SCIENCE ABSTRACTS.

Section A.—PHYSICS.

FEBRUARY 1909.

GENERAL PHYSICS.

194. *Gravimetric Determination of High Altitudes.* **A. Berget.** (Comptes Rendus, 148. pp. 59–60, Jan. 4, 1909.)—As the sensitiveness of the barometer decreases at higher altitudes the author proposes to apply gravimetric methods whose sensitiveness is constant. If p_1 and p_2 be the weights of the same body on the surface of the earth (radius R) and at the altitude h_1, then $p_1/p_2 = (R + h)^2/R^2$, or approximately $(p_1 - p_2)/p_2 = 2h/R$. On the Eiffel Tower, 300 m., $(p_1 - p_2)/p_2$ would be 1/10000. Instruments of the Threlfall and the Hecker types might be utilised. H. B.

195. *Mechanical Models of the Ether.* **J. J. Taudin Chabot.** (Phys. Zeitschr. 9. pp. 805–806, Nov. 15, 1908.)—The usual mechanical models contain some elastic element such as a spring or rubber band, so that the forces are not purely mechanical. A purely mechanical model may be based upon Sire's gyrostatic pendulum by balancing the gyrostat so as to reduce gravitation to zero, or by reducing the length of the pendulum to zero. By varying the ratio between the angular velocity of the rotating lens and that of the suspension any degree of elasticity from rigidity to perfect plasticity may be simulated. Such an arrangement is actually before us in the planetary system, owing to planetary rotations and revolutions. A deflection of a planetary axis is opposed by an "elastic" force proportional to the sine of the angle of deflection. Such forces are brought into play when the whole solar system describes a path which is not straight. There may be some connection between the motion in space of a planetary system and the varying inclination of the planetary axes. E. E. F.

196. *Testing Hardness of Metals.* (Frank. Inst., Journ. 166. pp. 447–451, Dec., 1908. Mech. Eng. 23. pp. 35–36, Jan. 8, 1909.)—A Committee Report on W. I. Ballentine's proposed test. A disc of metal is attached to the lower side of a drop weight, which falls on an anvil. The anvil carries a pin on its lower side, which rests in contact with the piece of metal to be tested. The diminution in thickness of the disc is the measure of hardness. Examples of the results of tests carried out with the apparatus are given. F. R.

197. *Collapse of Tubes under External Pressure.* **S. E. Slocum.** (Engineering, 87. pp. 85–87, Jan. 8, 1909.)—Discusses the results dealt with in Abstracts Nos. 1986 (1906) and 8 and 1121 (1907). By introducing a correction factor, $C=(d/D)^3 \times (t_{\text{min.}}/t_{\text{aver.}})^3$, into Love's formula for thin tubes we have collapsing pressure $P=2CE(t/D)^3/(1-m^2)$. The average values from Stewart's results (*loc. cit.*) give $C=0{\cdot}69$ for lap-welded steel flues. t is thickness, d the min., and D the max. diam., m is Poisson's ratio, and E is Young's modulus. Lamé's formula for thick tubes is correspondingly modified to $P=2uC_1t/D(1-C_1t/D)$, where $C_1=(d/D)^3=0{\cdot}89$, and u is the compressive strength, data as to which are lacking in the references given above. Assuming $u=88{,}500$ lbs. per sq. in., the formula agrees well with the results. It is considered that if suitable values of the correction factors be determined the formulæ will be of general applicability. F. R.

198. *Experiments in Aerodynamics.* **A. F. Zahm.** (Monthly Weather Rev., Washington, 36. pp. 277–281, Sept., 1908.)—Describes experiments for determining the law governing skin friction between smooth surfaces and air flowing freely over them. The following formula is given—

$$F=0{\cdot}00000778\,l^{0{\cdot}93}v^{1{\cdot}85},$$

where F is the friction in lbs. per sq. ft. of surface skin, l is the length of the surface in ft., and v the velocity of the air in ft. per sec. [see Abstract No. 2457 (1904)]. A table is given showing the friction values for various air speeds and lengths of plane. F is approximately uniform for varnished wood, paper, zinc, &c., but for coarse buckram is 10 to 15 per cent. greater at $v=10$ ft. per sec., and varies as v^2. The fact that for some surfaces the coefficients of friction of air and water are roughly as their densities is of importance. As the "impactual" resistances vary similarly for the two fluids, data obtained for one fluid may be applied in estimating for the other. Experiments to ascertain the contours of shapes producing minimum resistance are described which show that a well-designed torpedo is the form of least resistance for air as well as for water. The most favourable shape is that in which the frictional and pressural resistances are equal. Experiments are also described to ascertain the resistance for velocities between 250 and 1,000 ft. per sec., which is closely expressed by—

$$R=0{\cdot}000008v^2+0{\cdot}000000049v^3,$$

where $R=$ resistance in lbs. per sq. ft. and $v=$ ft. per sec., the projectiles used being wooden spheres. C. A. B.

199. *Effects of Electric Current on Concrete.* **U. J. Nicholas.** (Eng. News, 60. pp. 710–712 and 713, Dec. 24, 1908.)—Sand and cement concrete blocks with steel cores were made the anodes in iron pails which were the kathodes, the electrolyte being 3 per cent. sodium chloride solution. Blocks were aged for 1 month or upwards in fresh water before subjecting to the action of a current. Whether a constant current of 0·1 amp. or p.d. of 115 volts was maintained, the blocks cracked after periods which were shorter the greater the proportion of sand to cement, *e.g.*, 7 days with 1 cement, 3 sand; 16 days with 1 : 1; 28 days with neat cement, in each case under a current of 0·1 amp. The cracking is probably due to the pressure of the accumulated gas liberated at the electrode. The resistance increased under constant current to a maximum at the instant of cracking and then fell

to about the initial value. Under constant p.d. the resistance fell until cracks formed. With the current flowing in the opposite direction the concrete cracked. Conduction in the concrete is electrolytic. Steel corrodes at the anode when embedded in concrete under the conditions of these tests, but not at the kathode. F. R.

200. *Damping of Oscillations by Air Resistance.* **B. O. Peirce.** (Amer. Acad., Proc. 44. No. 2. pp. 68–88, Nov., 1908. Contribution from the Jefferson Phys. Lab., Harvard Univ.)—After a short historical summary of the subject, two forms of the equation of motion of a vibrator oscillating in a resisting medium are given, in which the resistance is assumed to be proportional to the first (Gauss's law) and second powers of the angular velocity of the vibrator. The decay of oscillations is then studied by means of photographic records obtained by means of short-period mirror galvanometers and other vibrating systems. With these, under a relatively strong air damping, there is an appreciable departure from the Gaussian law, unless the amplitude is very small. If the system be turned out of the position of equilibrium and then released, it moves through this position to an elongation on the other side corresponding to a displacement much smaller than the one from which it started; but after this the subsequent decrease of the amplitude takes place slowly and regularly, accompanied usually by a slowly decreasing logarithmic decrement. For any small number of swings after the first few, however, the constancy of the logarithmic decrement can often be assumed with sufficient accuracy for ordinary purposes. The moment of inertia of the swinging system cannot, as a rule, be computed with any fair approximation from a knowledge of the masses and the geometrical dimensions, for a comparatively large mass of air accompanies the visible system, and materially increases the inertia. By increasing the restoring moment the coefficient of damping generally increases rapidly, but the apparent moment of inertia usually remains practically unaltered, and if that moment comes from the torsional rigidity of a stiff wire the period frequently lengthens somewhat as the amplitude grows smaller. G. E. A.

201. *Lorentz-Fitzgerald Hypothesis applied to Dynamical and Gravitational Problems.* **H. A. Bumstead.** (Amer. Journ. Sci. 26. pp. 493–508, Nov., 1908.)—There is at the present time a general concensus of opinion, among those best qualified to judge, that the fundamental facts of optics and electrodynamics require us to assume that the ether does not partake (to any sensible extent) in the motion of material bodies which pass through it. The aberration of light is, perhaps, the most conspicuous of these phenomena, which it has hitherto been found impossible to account for on any other hypothesis without becoming involved in serious difficulties. All the phenomena in which there is relative motion of the source of light with respect to the observer, or of a material medium (through which light is propagated) with respect to source and observer, appear to require the above assumption, even those which at first seemed to lead to a conclusion somewhat different in form. Thus the experiment of Fizeau, in which he compared the velocities of light when going with, and against, a stream of water, was interpreted by Fresnel as indicating a certain entrainment of the ether. This interpretation was based on Fresnel's theory of refraction, which assumed that the ethereal density was increased in material media; and it is only the excess ether which must be carried by the matter. On the electron theory, however (and, indeed, on any resonance theory of dispersion and refraction), there is no

excess density of the ether in ponderable bodies; and it is not difficult to see that Fizeau's experiment requires a stationary ether. A result which leads to the same view has been obtained in electrodynamics by H. A. Wilson in measuring the electric force produced by moving an insulator in a magnetic field [see Abstract No. 2256 (1904)]. All such experiments known to the author upon the effects of relative motion give positive results which may be predicted from the hypothesis of a fixed ether, and the magnitude of the effects observed is in general of the same order as the fraction $\beta = v/V$, where v is the relative velocity involved and V the velocity of light. The theory of a stagnant ether leads us, however, in a no less direct manner to expect certain modifications in the phenomena of light and electricity when there is no relative motion of material objects, but when all the apparatus concerned as well as the observer are carried through the ether with the velocity v. The effects to be expected are of the order β^2; this is a very small fraction, even when v is the velocity of the earth in its orbit, but the possible accuracy of certain optical experiments is so great that these effects could certainly be found if they existed without some compensating effect to mask them. As is well known, these effects have never been found; the first conclusively negative results were obtained in the celebrated experiments of Michelson and Morley, and several other optical investigations have also failed to show the expected results. On the electrical side the problem has been attacked by Trouton and Noble, who hung up an electrical condenser by a torsion wire and looked for a torque which, on the theory of a stagnant ether, ought to exist when the condenser is carried along by the earth. Although the sensitiveness of their experimental arrangement was ample for the observation of the expected second-order effect, their result was also negative. The most obvious interpretation of these results is that the ether near the earth has the same velocity as the earth; but, as has been stated, it appears to be impossible to reconcile this view with the great mass of optical and electrodynamic evidence. The only satisfactory way out of this difficulty which has hitherto been suggested is the hypothesis put forward in 1892 by Lorentz, and which had been independently suggested but not published by Fitzgerald. According to this hypothesis, when any material body moves relatively to the ether its linear dimensions parallel to the direction of motion are contracted in the ratio of $\sqrt{1-\beta^2} : 1$, while the dimensions perpendicular to the direction of motion remain unchanged. If this contraction takes place in the interferometer of Michelson and Morley, and in the condenser of Trouton and Noble, their negative results are entirely explained on the theory of a stationary ether. As Lorentz points out, this contraction will be very small in any motions of material bodies which we can observe; for example, the diameter of the earth in the direction of its orbital path will be diminished by only 6·5 cm. by its motion. It would, moreover, be impossible to detect the shrinkage, however great it might be, by ordinary measurements, since the standards of length must shrink in the same ratio as the bodies to be measured. The author considers, however, that it would be quite misleading to leave the impression that this hypothesis depends for its credibility altogether upon the fact that it enables us to evade a serious difficulty, and that it cannot be disproved by ordinary means. The electrical forces between charged bodies (electrons) are modified by motion through the ether; and they are modified in precisely such a way that if a given system of changes were in equilibrium under these forces in a certain configuration when at rest, it would when in motion be in equilibrium in a configuration obtained from the first by the application of the Lorentz-Fitzgerald shrinkage. Now, it is a fundamental theorem in electrostatics that a charged system cannot be in equilibrium under the electrical forces alone; in the case of a collocation of electrons or atoms in equilibrium, the electrical forces must be balanced by other forces. If these inter-electronic forces are ethereal in origin and subject to the same laws as electromagnetic forces, then the Lorentz-Fitzgerald contraction would be expected *à priori*; and from this point of view the absence of the second-order effects is evidence for the ethereal nature of inter-atomic and inter-molecular forces. Forces of this character would suffice to account for the changed dimensions of moving bodies, even if the electrons themselves were left unaltered by the motion. But, as Lorentz has pointed out, we must also bring in dynamical considerations, which show that for complete absence of second-order effects the electrons themselves must suffer the same contraction. The experiments of Rayleigh and of Brace have shown that there is no double refraction due to the convection of transparent bodies by the earth. This implies that the periods of vibration of the electrons in the line of motion and perpendicular to it must be equal; and, in order that this may be so, the longitudinal and the transverse masses of the electron must be altered by the motion in the same manner as the forces in these directions. An electron which does not change its shape (such as the rigid spherical electron of Abraham) will not have this property; nor will an electron which alters its form in any other manner than that described above for material bodies (such as the constant-volume electron of Bucherer). The electron proposed by Lorentz obviates these difficulties. If we assume that it is, when at rest, a sphere of radius a, it must, when in motion with velocity v, become an ellipsoid of revolution with its shorter axis in the direction of motion and equal to $a\sqrt{1-\beta^2}$, the dimensions perpendicular to the motion remaining unchanged. If m_1 and m_2 are its longitudinal and transverse masses at speed v, and m_0 the mass for infinitesimal velocities, we have $m_1 = m_0(1-\beta^2)^{-3/2}$, and $m_2 = m_0(1-\beta^2)^{-1/2}$. With this electron Lorentz has shown that no optical or electrical effects of motion through the ether can be detected. The subject has been approached from a different standpoint, and treated very instructively by Einstein. His fundamental postulate amounts to a denial that it is possible to observe any effects of uniform convection through the ether in which all the bodies concerned (including the observer) take part. This he calls the *Principle of Relativity*; the significance of the name is that only relative motion of one portion of matter with respect to another can produce any observable effect; uniform motion, relative to the ether alone, becomes as impotent, if not as meaningless, as absolute motion. Einstein considers two sets of co-ordinate axes, one at rest in the ether (x, y, z), while the other (ξ, η, ζ) moves with the constant velocity v in the x direction. He defines carefully the meaning of "time," (t in the fixed system, τ in the moving system) by means of clocks distributed at various points, some at rest with the fixed axes, and some moving with the moving axes. The clocks are supposed to be synchronised by light-signals. By kinematic considerations he shows that, in order for the principle of relativity to hold, we must have $\xi = (1-\beta^2)^{-1/2}(x - vt)$, $\eta = y$, $\zeta = z$, and $\tau = (1-\beta^2)^{-1/2}(t - vx/V^2)$. The distances x, y, z are measured by standards at rest, ξ, η, ζ by standards in motion. The distance between two points on the x axis, when measured by the first, is $x_2 - x_1$; when measured by the second, it is $\xi_2 - \xi_1 = (x_2 - x_1)(1-\beta^2)^{-1/2}$. The length of the moving standards, when parallel to the axis of x, are thus $(1-\beta^2)^{1/2}$ times the fixed standards; when perpendicular to x, they have the same length as the fixed standards. In order, therefore, that Einstein's principle should hold, it is necessary that all moving objects should suffer the Lorentz-Fitzgerald contraction. It further follows that the moving clocks run slower than the fixed ones; if a clock at rest beats seconds, it must, when in motion, have a period of $(1-\beta^2)^{-1/2}$ sec. It is possible that the principle of relativity may come to be regarded as one of the fundamental empirical laws of physics, occupying a position analogous to that of the second law of thermodynamics. It rests on a similar basis, in that no deviations from it have been observed. Indeed, the analogy may be made more complete by showing that the denial of the principle leads to a third kind of perpetual motion, by which the kinetic energy of any body might be exhausted and the body be brought to rest with reference to the ether. There is, however, an enormous difference in the breadth of the evidence on which the two principles rest. Violations of the principle of relativity lead only to minute effects, which must be sought for in difficult and recondite experiments. The fact remains, however, that, so far as our knowledge extends, the principle holds; the most reasonable course in regard to it, and that which promises to be most fertile in results, is to accept it provisionally and to develop its consequences. This will doubtless lead to further experimental tests; and even apart from direct tests, one may regard the evidence for the principle as being strengthened if it introduces simplification and harmony into the theory of phenomena which are apparently remote from those that led originally to its adoption. As the dimensions of all bodies are altered by motion through the ether, it is plain that such motion must be taken into account in the exact theory of even purely dynamical phenomena. The author then applies the principle of relativity to the cases of the torsional pendulum, the elastic rod pendulum, and the gravitational pendulum, and finds, in each case, it follows from the hypothesis, not only that all mass is electromagnetic, but also that it varies with the speed in the specific manner of Lorentz's electron. Also for the gravitational pendulum it is found that the gravitational force between two bodies moving with or perpendicular to the line joining them corresponds with the function of the velocity which expresses the electric force between two moving charges. Applications to gravitational effects on the astronomical scale are also made, but the author concludes that in this region our present observational knowledge of gravitation is not sufficiently exact either to exclude the general application of the principle of relativity or to supply evidence in its favour. E. H. B.

202. *Motion of Projectiles after Penetration.* **T. Terada** and **M. Ôkôchi.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 12. pp. 404–414, Oct., 1908.)—The rotation and deviation of oblong projectiles have been already discussed by many authorities, but the motion of a projectile after penetrating obstacles seems to have been utterly neglected, except for a few investigations on the special case of a spherical projectile ricocheting on water. Since, if the resistance of the obstacle to be penetrated were so great as to deform the projectile, its subsequent motion would be too complicated for a successful study, the authors in their experiments chose as a suitable resistance a cake of soft putty attached to a piece of pasteboard. In order to record the motion of the projectile paper screens were used along the path of the projectile, which left its traces in the screens. The following are the chief conclusions drawn: (1) In many cases the bullet was deflected after penetration toward the left and below the normal trajectory, contrary to the ordinary drift in air of the bullets with right-handed twist; (2) the lateral impulse received by the projectile during the penetration was parallel to the direction of deflection of the top (or nose) of the bullet; (8) generally, the lower the muzzle velocity the more remarkable is the deflection after penetration. The paper is illustrated by a plate showing the traces left by seven bullets at different speeds, each through ten or more screens. The gyroscopic motion is also dealt with by Euler's equations. [See also Abstract No. 217 (1909).] E. H. B.

203. *Anomalies in the Viscosity of Anisotropic Liquids when in a State of Hydraulic Flow.* **E. Bose.** (Phys. Zeitschr. 10. pp. 32–36, Jan. 1, 1909. Physikal.-chem. Laborat. d. Kgl. techn. Hochschule, Danzig-Langfuhr., Nov., 1908.)—Two kinds of flow are to be distinguished, viz., an ordinary flow which obeys Poiseuille's law, and in which all particles equi-distant from the walls of the tube are moving with the same velocity; and the hydraulic or irregular flow which does not obey Poiseuille's law. The author has previously shown that the turbid anisotropic liquids represent molecular swarms which tend to arrange themselves in a particular direction when in a state of flow. Such a swarm will be more easily deformed in its preferential direction than in those directions perpendicular to it, and when flowing through a tube in harmony with Poiseuille's law will tend to set themselves parallel with the axis of the tube. If, however, the liquid is in a state of hydraulic flow, this orientation will no longer take place to the same extent, and the less so the greater the swirling in the liquid, *i.e.*, the more the fall of pressure produces deviation from Poiseuille's law. It is therefore to be expected that in increasing the pressure under which flow occurs the anomalies in the viscosity of anisotropic liquids will become less and less prominent. This conclusion has been tested by the author in the case of anisaldazin and has been confirmed. The author therefore considers that a mechanical proof has been obtained that there is orientation in anisotropic liquids. A. F.

204. *Frequency of the Mean Cloudiness at Batavia.* **J. P. van der Stok.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 366–379, Dec. 23, 1908.)—Hourly observations of the amount of cloud have been made at the Observatory of Batavia from 1880 to 1905, and from these 26 years the frequency of the mean daily cloudiness, on the scale 0–10, has been determined for each month. To these figures the author has applied (1) Pearson's frequency formula, type I; (2) a formula of his own (*loc. cit.* 10. pp. 799–816). Comparisons between the values calculated from the formulæ and those obtained directly from the observations are made for the periods, East monsoon, West monsoon, transition period. R. G. K. L.

205. *Flow of Gases through Capillary Tubes at Low Pressures.* **H. Eger.** (Ann. d. Physik, 27. 4. pp. 819–848, Nov. 26, 1908. Extract of Inaug.-Dissertation, Würzburg, 1908.)—The author has made a series of experiments on the coefficient of viscosity for air and hydrogen under various conditions, the object being to find out how the coefficient depends upon temperature, the dimensions and curvature of the tube, and on the material of which the tube was composed. The method consists in allowing the gas to flow along a capillary tube, spiral or straight, from one to another flask of equal capacity under a pressure-difference which ranges from 0·00016 cm. of mercury upwards. Mercury traps were used instead of stopcocks to start and cut off the stream of gas, and the pressures were measured by McLeod manometers. In order to determine the volume of gas v transferred from one vessel to the other we have $V(p_1 + p_2)/2 = v(p_1 - p_2)$, where V = volume of either vessel, p_1 and p_2 are the pressures in the vessels before the experiment,

and $p_2 =$ final pressure of gas in the vessel to which the gas has flowed. In the case of the spiral tubes the mean internal radius was calculated by measuring the time required for a known volume of water to pass through under constant pressure (assuming the coefficient of viscosity). From an interesting series of curves showing the relation between the coefficient and the pressure it is seen that the coefficient of viscosity increases with increase in the radius of the tube but is independent of the length of the tube. The value of the coefficient is unchanged if a silver tube be substituted for glass, but with a copper tube smaller values of the coefficient are found. The suggestion is made that the latter may be due to roughness of the surface of the tube. Curvature of the tubes produces a decided effect on the coefficient at low pressures. In conclusion, the author measures the coefficient for air and hydrogen at several temperatures between —190° and 200° C.

W. C. S. P.

206. *Variation of Climate.* **H. Arctowski.** (Comptes Rendus, 147. pp. 1438–1440, Dec. 21, 1908.)—The author has compared the temperature means for decades with the averages for the past 50 years. He finds that the differences are not alike in sign and magnitude at different places, but that in a number of cases the divergencies at one station are the opposite of those at another. Osborne, Isle of Wight, and Lyons seem to be such a pair; also Archangel and Nertshinsk. He has also examined in detail the temperature records for a large number of places for the years 1891–1900, and arrives at the conclusion that some years are generally cold, others generally warm. The amount of compensation between the various stations does not seem to be sufficient to allow us to assume a constant mean temperature at the earth's surface. Variations in the intensity of solar radiation are suggested as the cause of this. Only a few figures are quoted as illustrations from the tables on which these conclusions are based. R. G. K. L.

207. *Spring Frosts at Williamstown, Mass., in* 1907 *and* 1908. **W. I. Milham.** (Monthly Weather Rev., Washington, 36. pp. 250–254, Aug., 1908.)—The observations [see Abstract No. 249 (1906)] have been continued. Spring frosts may be expected from the last days of April all through May on still, clear nights, with the wind almost invariably from NW., especially on the first or second night following the passage of a depression. The air is very dry, and the dew-point lies so low that it plays no part in determining the temperature drop from the maximum of a day to the following minimum next morning. Owing to the influence of clouds, changes in the wind, &c., the drop, on average 16·9° F., is far from constant, and ranged from 31° to 7° F. Plant temperatures may go considerably below the real air temperatures, because the plants are in the open, near the ground (not at shelter above the ground as the thermometers), and because the variations in temperature over a limited area may amount to several degrees. In the coldest part of the village the temperature of the vegetation in the open may be 11° lower than the minimum in the shelter. H. B.

208. *Rainfall and the Yield of Springs in Limousin.* **P. Garrigou-Lagrange.** (Comptes Rendus, 148. pp. 60–62, Jan. 4, 1909.)—The effects of a deficiency in rainfall continue to show in the yield of springs for several years. Limoges received, in 1906, 76 mm. less than the normal amount of rain (the summer figure was —85 mm.); the deficiency for 1907 was 9 mm.

(—185 mm. in summer), and the deficiency for 1908, 47 mm. (—125 mm. in autumn). Yet the flow of the river Vienne, at Limoges, in m.³ per sec., was +0·4 (above normal) in 1906, —0·8 in 1907, and —1·1 in 1908 (—4·0 in autumn). The outlook for 1909 is not favourable, therefore, and with the increase of hydro-electric power-plants rivers threaten more and more to become occasional torrents. **H. B.**

209. *Remarkable Inversion of Temperature.* **K. Bamler.** (Monthly Weather Rev., Washington, 36. pp. 283–284, Sept., 1908.)—Under the title "Scientific Ballooning and Weather Forecasts," this article contains an account of a balloon ascent from Elberfeld (Prussia) on Nov. 6, 1907, in which a remarkable inversion of temperature was encountered. At ground level, with light fog, the temperature was 2° C. From 1,500 to 2,000 m. the temperature was 9° C., relative humidity 14 per cent. **R. G. K. L.**

210. *New Kite Station on Lake Constance.* **E. Kleinschmidt.** (Monthly Weather Rev., Washington, 36. pp. 284–285, Sept., 1908.)—A vessel of 350 h.p., capable of a speed of 19 knots, provides facilities for obtaining daily ascents of kites or balloons under practically all conceivable wind conditions. If the wind is too light, the boat is run against it, and thus sufficient relative motion is obtained to enable the kite to be raised. On the other hand, on days of gale the effective wind is reduced to working velocities by running before the wind. The station is maintained by the German Government, and the results obtained are telegraphed each day to the principal forecasting centres in Germany. **R. G. K. L.**

211. *The Short-period Variable W Ursæ Majoris.* **J. M. Baldwin.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 78–90, Nov., 1908.)—This variable star ($\alpha = 9h. 36m. 44s.$, $\delta = 56° 24·6'$, 1900), which has a period of only 4 hours, was discovered by Müller and Kempf, of Potsdam, who have already published a light-curve and ephemeris. The author made 268 observations at Potsdam during the past year. A question arises as to whether the period is constant or not, the period apparently having increased during the latter part of the series. The data, however, are insufficient to settle the point. The light-curve deduced from his observations, and reproduced in the paper, shows that the variation in light is continuous, and that the curve for three-quarters of an hour on each side of the minimum is nearly symmetrical; then, however, the ascending branch turns somewhat sharply, and the increase to maximum is much slower than the subsequent decrease after maximum. The maximum occurs about 2h. 10m. after minimum, and is much less sharply defined. On comparing the curve with Müller and Kempf's it is found that: (1) The amplitude of the present curve is less. (2) The minimum is less sharply curved. (3) The gradual rise to maximum agrees with their suspected depression in the curve. (4) The curves after maximum till near minimum are practically identical. A list of all minima published by other observers is appended to the paper. **A. E.**

212. *Inclinations of the Planes of some Spiral Nebulæ to the Galaxy.* **H. K. Shaw.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 72–77, Nov., 1908.)—Measurements were made of 25 spiral nebulæ from Isaac Roberts' photographs in order to test whether there is any connection between the planes of these nebulæ and that of the Milky Way, as appears possible in the case of binaries and long-period variable stars [see Ibid. 67. p. 352 and Abstract

No. 215 (1908)]. The assumption is made that each nebula is circular in form, and appears elliptical owing to the inclination of its plane to the line of sight. This inclination is determined by measuring the axes of the nebular ellipse, and as the sign is ambiguous, two equally likely poles are found for each nebula. Nearly circular nebulæ are excluded, owing to the difficulty of estimating their inclinations. The galactic latitudes of the poles are tabulated. (The galactic longitudes of the poles were also calculated to see whether there was any trace of clustering in longitude, but as none such was found, they are not given in the table.) The poles show some tendency to congregate near the galaxy, but this may be due to the fact that the selected nebulæ are not uniformly distributed. It can only be said that the evidence is rather for than against a clustering of the poles of the nebulæ near the galaxy, and more information will be required before any definite opinion can be advanced. A. E.

REFERENCES.

213. *Work of the Reichsanstalt in* 1907. (Engineering, 86. pp. 818–819, Dec. 18, and pp. 867–869, Dec. 25, 1908.)—[See Abstract No. 1230 (1908).]

214. *Portland Cement for Use in the Tropics.* **W. C. Reibling** and **L. I. Salinger.** (Eng. News, 60. pp. 612–615, Dec. 3, 1908. Abstract from Philippine Journal of Science, 3. 3. June, 1908.)—Specifications, tests, and conditions affecting the properties of Portland cement for use in tropical climates, particularly in the Philippines, are discussed at length, and experimental data are given upon some points. F. R.

215. *Graphic Statics of Reinforced Concrete Sections.* **W. Dunn.** (Engineering, 86. pp. 847–850, Dec. 25, 1908.)—Examples of graphic treatment of common sections, based upon methods given by Mohr (Handbuch für Eisenbetonbau, vol. iii.), are given with diagrams. The methods are useful when it is desired to avoid calculation. F. R.

216. *Principle of Relativity.* **P. Frank.** (Ann. d. Physik, 27. 4. pp. 897–902, Nov. 26, 1908.)—Referring to Minkowski's attempt to introduce the Lorentz transformation into mechanics [see Abstract No. 1990 (1908)], the author shows that if in Minkowski's axioms for the electrodynamics of moving bodies the mechanical or "Galilean" transformation $z' = z - qt$ is substituted for the Lorentz transformation, the result represents the old Hertzian equations for moving bodies. E. E. F.

217. *Photographs of Projectiles in Flight.* **T. Terada** and **M. Ôkôchi.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 12. pp. 398–404, Oct., 1908.)—Following E. Mach, L. Mach and Salcher, and others, the authors have made photographic studies of projectiles, including the sporting gun bullet, and especially of the wave phenomena accompanying the penetration of infantry rifle bullets into different obstacles. The paper is illustrated by reproductions of twenty-four of the photographs. E. H. B.

218. *Damping of Long Waves in a Rectangular Trough.* **R. A. Houstoun.** (Phil. Mag. 17. pp. 154–164, Jan., 1909.)—Mathematical.

219. *Parallaxes of Nebulæ G.C. 4964 and N.G.C. 7027.* **E. Huss.** (Ark. för Mat. Astron. och Fysik, Stockholm, Vol. 4. No. 28. pp. 1–11, 1908.)—The values obtained for the parallaxes by recomputation differ little from those of Wilsing. It is considered proved that the second nebula is much the more distant. L. H. W.

LIGHT.

220. *Some Diffraction Phenomena.* **A. Winkelmann.** (Ann. d. Physik, 27. 5. pp. 905–954, Dec. 15, 1908.)—When the eyepiece of the telescope of a spectrometer, which is focussed through a grating on the collimator slit, is displaced, the system of diffraction bands seen becomes indistinct and disappears, and a new system appears of different band-distance; this repeats itself several times. The paper deals with this effect with some minuteness, and the position of the new band systems, the distance of the bands, and the distribution of intensity in these are deduced from theory and the results compared with those obtained by experiment. G. E. A.

221. *Telescopic Vision.* **G. Johnstone Stoney.** (Phil. Mag. 16. pp. 318–339, Aug.; 796–811, Nov., and pp. 950–979, Dec., 1908.)—A discussion of the defects of the telescope and an inquiry respecting the process by which nature forms those images which are formed in optical instruments or on the retina. Two images and their relation to one another are considered. One of these is the image of the celestial object presented by the telescope to the eye. The other, referred to as the concentration image, can be formed by the same identical light, but is an entirely different image. The method of analysis which has proved to be the most efficient in tracing out how images are actually formed by nature is the analysis of the light within any space occupied by a uniform medium into its constituent undulations of flat wavelets. It is by the interferences of these undulations that the image is formed. The image seen in astronomical observations represents the celestial object imperfectly. What is seen is an *eidolon,* or a model of the planet, of such a size and with such additions and imperfections and blurring together of details as would cause it to have, if viewed by the naked eye from the distance of most distinct vision, exactly the same appearance as the image seen in the telescope. An apparatus is described by which experiments can be made that will disclose the imperfections which of necessity exist in the images furnished by astronomical telescopes, that will indicate the causes of these imperfections and how they may be mitigated. In the second part of the memoir a working model of the apparatus is used to investigate the nature of the images obtained. In the third part a discussion is given of why it is that, when a large and a small object exactly similar to one another are examined with the same telescope, the large one will be seen satisfactorily, while the small one, though of precisely the same shape, will, if small enough, appear when viewed through the telescope to be transformed into something unlike itself. In the eighth and concluding chapter the method of formation of a telescopic image is considered and its imperfections and distortions are further investigated, experiments with the microscope being used to throw light upon the subject. J. J. S.

222. *Singular Directions in Pleochroic Crystals.* **W. Voigt.** (Ann. d. Physik, 27. 5. pp. 1002–1024, Dec. 15, 1908.)—In every pleochroic crystal there are four directions (twist axes) in which there are propagated two waves rotating in the same sense, vibrating circularly, and with equal velocity and equal absorption. These directions may be calculated and constructed by means of the polarisation and absorption constants which characterise the crystal. Between these twist axes extend continuous sets of directions along which either $(1 - k^2)/n^2(1 + k^2)^2$ or $k/n^2(1 + k^2)^2$ possess equal values for both waves, n being the index of refraction and k the absorption index. These sets unite together to form complete conical surfaces which contain either two or all four twist axes; the portions bounded by the latter directions join together without interval. Geometrical considerations would lead to the consequence that the two waves referred to above would combine to form one propagated in the twist axis. As a consequence, if a surface is prepared on the crystal normal to a twist axis, and there is allowed to fall normally upon it a circularly vibrating wave which has a sense of rotation opposite to that of the rotation axis, then this wave must be totally reflected. Actually the reflection is partial in certain cases. The geometrical direct evident equivalence to a single wave, of two circular waves rotating in the same sense, equal in speed and equally strongly absorbed, is not applicable for all deductions. J. J. S.

223. *Magnetic Dichroism of Calcite and Dolomite.* **G. Meslin.** (Comptes Rendus, 147. pp. 1277–1279, Dec. 14, 1908.)—A continuation of research on magnetic dichroism of mixed liquids constituted by associating a liquid with an anisotropic crystalline substance. A table is given which shows that, for a large number of liquids, the two substances form, with any one liquid, liquors which have inverse properties as regards their magnetic dichroism; *i.e.*, if the dichroism is positive for the one liquor, it is negative for the other, and the property changes sign for both, with liquids having a refractive index about 1·61. G. E. A.

224. *Some Fundamental Laws of the Absorption and Absorption Spectra of Gases.* **K. Ångström.** (Ark. för Mat. Astron. och Fysik, Stockholm, Vol. 4. No. 30. pp. 1–13, 1908.)—A review of the work carried out in the author's laboratory upon the absorption of gases. The paper deals more especially with the relation between the pressure and the absorption of gases, and also with the presence of inactive diluents. There is little doubt that the line spectra of gases are a different phenomenon, and that they conform to different laws. CO_2 and CO have more particularly been examined, the following routine being adopted: A long absorption tube was used divided by a transparent partition into two portions which were, however, connected by a tube and stopcock. The whole absorption tube was first exhausted, and then the gas under investigation was passed into one chamber and its absorption measured; the stopcock between the two chambers was then opened and the absorption again determined. An inactive diluent, air or H_2, was then allowed to pass in until atmospheric pressure was reached, when again the absorption was determined. Three values of absorption were obtained, a_1, a_2, and a_3; it was found that $a_3 = a_1 > a_2$. It is evident from this that Beer's law does not hold, and that the absorption of a gas mixture is greater than that of its constituents. Further, it would appear that the absorption is in some way dependent upon the collisions between the gas particles.

E. C. C. B.

225. *Some Physical Properties of Current-bearing Matter.* V. *Refractive Index.* **P. R. Heyl.** (Phys. Rev. 27. pp. 502–508, Dec., 1908.)—The author has found that a current of 50 amps./cm.^{2} does not change the refractive index of electrolytic copper by as much as 2 per cent. The method adopted was to measure the elliptic polarisation of sodium light produced when plane-polarised light is reflected from the polished metallic surface. The mirror was prepared by depositing a layer of electrolytic copper 1 mm. thick on a thin sheet of copper, and it was mounted at the centre of a spectrometer so that it could be rotated in its own plane. Current was supplied to the test piece by a small spring clip, the jaws of which were insulated from each other. The jaws of the clip could be made to clasp either the upper and lower or the right and left edges of the mirror. The current was led in and out by wires attached to the jaws so that it could be made to flow either horizontally over the surface or vertically. The collimator and telescope of the spectrometer were fitted with nicols, and in front of the nicol attached to the telescope was a Soleil-Babinet compensator composed of two quartz wedges and one quartz plate. Then if Δ be the difference of phase introduced by reflection, ψ the azimuth of restored polarisation after the light has passed through the compensator, Drude has shown that the refractive index is—

$$n = \sin\phi \tan\phi \frac{\cos 2\psi}{1 + \cos\Delta \sin 2\psi},$$

where ϕ is the angle of incidence of the plane-polarised light. The compensator was calibrated by means of plane-polarised light. [See also Abstract No. 8 (1908).] W. C. S. P.

226. *Selective Radiation from various Solids.* **W. W. Coblentz.** (Bureau of Standards, Bull. 5. pp. 159–191, Nov., 1908.)—Our knowledge of the emission of radiant energy from various substances at different temperatures is limited. It has been found that the emission spectra of the Bunsen flame and of gases in vacuum tubes are composed of sharp emission bands superposed on a weak continuous spectrum, whereas solids generally emit continuous spectra. The present paper contains the emission spectra of numerous substances of which it has not been practicable to study the absorption spectra. The substances examined were electrical insulators, and were in the form of solid rods made in the oxyhydrogen flame or in the form of thick layers placed upon a heater. They were given an initial heating by means of an alcohol or blast lamp, and the heating was then maintained by means of an electric current from the secondary of a 2,000-volt, 300-watt transformer, a resistance being placed in the primary to regulate the current. The rods, provided with Pt terminals, were securely mounted in glow-lamp sockets which could be rigidly fixed in front of the spectrometer slit. Atmospheric absorption bands were entirely eliminated by enclosing the optical parts of the apparatus. As is usual in these experiments, it was not possible to determine the temperature directly, so that the watts supplied are given and also the dimensions of the rods. All curves are reduced to the normal spectrum by dividing the observed galvanometer deflections by the slit-widths expressed in wave-lengths. The curves showing the relation between the emissivity and the wave-length for a zirconium oxide rod are conspicuous for their sharp emission band at $4{\cdot}8\mu$, which remains superposed upon the continuous background even at bright yellow heat (1,400° about). The gradual shift of the maximum of intensity of emission towards the short wave-lengths, with rise of temperature, is well illustrated. A large number of other substances were examined in the form of rods. The substances that could not be melted were made into a paste and spread upon the heater tube of a Nernst lamp to a depth of 1 to 1·5 mm., the heater tube being covered with a fine coil of

Pt wire. The tube itself cannot transmit any radiation if the substance is well powdered and is pasted on thick. Pure ZnO_2 heated by this method gave sharp emission bands at 2·88 μ and 4·8 μ, but the temperature was lower than in the case of the rod heated electrically. It was found that a rod of 99 per cent. ThO_2 + 1 per cent. Ce_2O_3, heated white-hot electrically, gives an entirely different spectrum from the Welsbach gas-mantle, which is of the above composition. From the fact that many of the oxides examined have an emission band in common at 2·85 μ the author concludes that it must be due to the common oxygen atom. It was also found that the emission spectra when smooth generally show a depression at 3·2 μ. This cannot be due to absorption by the atmosphere or by the fluorite prism. The emission spectra of Pt and of the heater tube were examined, but neither showed this depression, so that we must conclude that it is peculiar to these oxides. The author has also examined the isochromatic radiation curves of Pt, a Nernst glower, and of oligoclase. The curves for the last-mentioned differ from the others in that the emissivity is proportional to the rate of supply of energy. Thus the observed sharp emission bands given by oligoclase behave like emission lines of a gas. For further information the original paper should be consulted.

W. C. S. P.

227. *The Luminous Equivalent of Radiation.* **P. G. Nutting.** (Bureau of Standards, Bull. 5. pp. 261–308, Nov., 1908.)—The author points out the ambiguity in the meaning attached to the word "light." It is sometimes applied to the subjective sensation, and sometimes to the objective stimulus causing, or capable of causing, this sensation. The relation, however, of light to radiation involves primarily the concept of the luminous equivalent of radiation which is capable of exact definition. But while the heat equivalent of mechanical energy is a fixed quantity, the luminous equivalent of radiation varies enormously with the wave-length of the radiation concerned and to a slight extent with its intensity as well. The principle of the conservation of energy does not apply to light either objective or subjective. Light is not a simple multiple of radiation, but a complicated function of its quantity, quality, and duration. This paper is a preliminary attempt to formulate these complex relations. In order to express light in terms of mechanical units, or radiation in terms of light units, it is essential that the following three relations be definitely formulated: (1) the spectral distribution of the radiation in question, (2) the sensibility of the eye to radiation in different parts of the spectrum, and (3) the sensibility of the eye to variations in the intensity of the radiation. The properties of the eye as a physical instrument are first discussed. Its sensibility is highest between 500 and 600 $\mu\mu$. Good seeing requires radiation between 410 and 760 $\mu\mu$, and the extreme limits for most eyes are 380 $\mu\mu$ in the violet and 770 $\mu\mu$ in the red. The spectral sensibility curve has a maximum in the green. At low intensities the maximum lies between 500 and 520 $\mu\mu$ in about 90 cases out of a hundred. It is nearly—or possibly quite—independent of colour blindness, partial or complete. At moderate and high intensities the highest part of the visibility curve broadens and shifts slightly towards the yellow. The sensibility of the eye to radiation falls off steadily with increasing intensity. The ratio of optical intensity to intensity of radiation increases more rapidly for red than for blue and green (Purkinje phenomenon). The ratio of the least perceptible increment of the intensity to the intensity is approximately (1) independent of the intensity (Fechner's law), (2) independent of wavelength (König's law), and (3) independent of the individual. Visual acuity or resolving power appears to be approximately proportional to the luminosity and independent of the colour and the individual. The growth and decay of the visual responses with time appear to follow the ordinary exponential law. The data obtained by König, Pflüger, and Langley are employed to find the visibility curve at low intensity. The author obtained the following figures for the intensity of the spectrum of a Nernst lamp by means of a Rubens thermopile and a Lummer-Brodhun photometer :—

Wave-lengths in $\mu\mu$	620	566	566	595
Candles per watt	8·1	12·1	13·5	11·8

The data given by Broca and Sulzer enable the visual sensation as a function of the time to be found. In this connection the critical frequency at which flicker is just imperceptible is mentioned and a formula is deduced for it. It is pointed out that the properties of the average human eye should be tabulated. Numerical values should be found for the luminous equivalent of radiation at each wave-length and for all intensities. Approximate formulæ might also be given. The question of what is meant by "white" light is considered. It is remarkable to what extent light may differ from white and yet with steady exclusive use appear but slightly tinted. In practice the visual colour accommodation is very large. Highly coloured illumination like that from the mercury vapour lamp, although not injurious to the eyes, is of low visual economy; that is, a higher luminosity is required to produce the same comfort and acuity of vision. Exner's results show that at least two of the three sets of cones are in use with monochromatic illumination in every part of the spectrum except the violet and the extreme red. As a standard of luminosity a glow-lamp burning in air in the same way as a Nernst lamp would appear to be the most practicable. The main objection to the standard suggested by Steinmetz is the difficulty in getting sufficient intensity to make radiometry practicable. A somewhat complicated formula is obtained connecting luminosity and temperature. The practical applications of the results obtained to photometry, pyrometry, chemical work, astronomy, polarimetry, and spectroscopy are explained. In conclusion, the author makes an appeal for a scientific nomenclature. A. R.

228. *Coronas with Mercury Light.* **C. Barus.** (Amer. Journ. Sci. 27. pp. 73–81, Jan., 1909.)—The strong green line of a mercury lamp has been used as the source of illumination in examining coronas, as the light given by it is homogeneous and at the same time very intense. The results show that the green disc and the first green ring alternately vanish as the result of the interference phenomenon superimposed on the diffraction phenomenon. If, therefore, the nucleation of a highly charged medium is systematically reduced, a series of angular diameters may be obtained both for the green disc and the inner or outer edge of the first green ring. From the loci of these values the position of the first diffraction minimum for green light may be inferred, and the size of droplets computed from the usual equation for small opaque particles. If the reduction of the nucleation is accomplished by successive partial exhaustions, all of them identical, while filtered air is allowed to enter the receiver systematically between the exhaustions, the nucleations of any two consecutive exhaustions should show a constant ratio. Allowances must, however, be made for the subsidence during the later fogs and for time losses, if any. This is the method hitherto used by the author. But in the case of mercury light it is now possible to compare the latter with the former (diffraction) method of obtaining the diameters of particles, with a view to throwing definite light on the optical phenomenon. Subsidence methods are out of question for large coronas, as these are fleeting and pass at once into smaller coarse coronas. The results of the two methods may be regarded as coincident as long as not more than 800,000 nuclei per c.cm. or diameters of particles not smaller than 0·0008 cm. are in question. For larger numbers and smaller diameters the divergence rapidly increases. For particles larger than the size given the optical loss per exhaustion exceeds the exhaustion ratio, a result which is satisfactorily explained by the cotemporaneous subsidence of these relatively large particles. For particles smaller than the limit in question the loss computed by the optical method is larger than the exhaustion loss, as if fresh nuclei were made available at each exhaustion. This result is discussed in detail in the paper. J. J. S.

229. *Rotatory Power at Low Temperatures.* **J. Becquerel.** (Comptes Rendus, 147. pp. 1281–1284, Dec. 14, 1908.)—A study of the rotatory power of cinnabar, of which crystalline plates had been obtained with parallel faces. Photographs of spectra are given showing the rotatory dispersion at 18° and −188°. From these it is found that the rotatory dispersion is connected with the absorption. The rotatory power diminishes, for any given wave-length, with cooling, and this effect can be seen in smaller degree in quartz. G. E. A.

230. *Specific Charge of Electrons.* **A. Cotton** and **P. Weiss.** (Comptes Rendus, 147. pp. 968–970, Nov. 23, 1908.)—All the spectrum lines of Mendeléeff's second group of metals which belong to the second subsidiary series are split up in a magnetic field in such a manner that the difference of frequencies of the extreme components is the same for all. A single constant $K = \partial\lambda/H\lambda^2$ suffices for completely defining the Zeeman-effect in each. Measurements with zinc lines give for K the value $1{\cdot}875 \times 10^{-4}$ [see Abstract No. 1582 (1907)], a value larger than that hitherto accepted, but smaller than that of Stettenheimer [Abstract No. 52 (1908)]. A calculation of the specific charge e/m by Lorentz's method gives the value $3{\cdot}534 \times 10^7$, or twice $1{\cdot}767 \times 10^7$. This last figure agrees remarkably well with Classen's recent value for slow kathode rays, viz., $1{\cdot}773 \times 10^7$, and the doubling of the value accords with Ritz's theory. On the other hand, Lohmann [Abstract No. 617 (1908)] has found the value $1{\cdot}77 \times 10^7$ for helium lines, and correspondingly, a value for $K = 0{\cdot}94 \times 10^{-4}$ or exactly half the author's value. Helium lines therefore give in a magnetic field the long looked for "normal" triplet, instead of the "pure" triplets given by non-series lines. E. E. F.

231. *Spectrum of Canal Rays in Helium.* **H. Gerdien** and **R. Holm.** (Ann. d. Physik, 27. 4. pp. 844–858, Nov. 26, 1908. Physikal. Inst. d. Univ., Göttingen, April, 1908.)—The production of the helium, the filling of the discharge tube, which is of quartz, and the arrangements for photographing and measuring the spectra of the canal rays are described. Only three of the helium lines exhibited the Doppler-effect, namely, 4471·6, 4026·3, and 3888·8. The velocity of the canal rays at which the Doppler-effect is observed is much greater than in the case of hydrogen, and the ratio of the intensity of the displaced band to that of the "rest" line is much smaller than with hydrogen. Further, the intensity curve is flat and extended, showing a sharp minimum in the case of the line 3888·8 but a slightly marked minimum in the case of the other two lines. From the displacement and the kathode p.d.,

and assuming the same electric charge as for the hydrogen ions, the mass of the helium ions appears to be 20 to 35 times as great as that of the hydrogen ions, but it should be remembered that the velocity in the canal rays is only a fraction of the velocity in the kathode dark space, and that this fraction is probably much smaller in the case of helium than in the case of hydrogen.
S. G. S.

232. *The Production of Line Spectra.* **E. Goldstein.** (Ann. d. Physik, 27. 4. pp. 773–796, Nov. 26, 1908.)—If a vertical glass tube be taken, fitted with an electrode at each end, the anode at the bottom, and a quantity of perfectly dry powdered alkali metal haloid salt put in the tube until the anode is more than covered, then when the discharge passes under reduced pressure it always follows a path just between the glass wall and the powdered salt. The spectrum of the discharge is that of the alkali metal and is intensely brilliant, corresponding indeed to the arc spectrum of the element in question. If now a Leyden jar be used, the spectrum of the halogen is seen, and based upon this the author gives details for the preparation of tubes for the examination of many elementary bright-line spectra, *e.g.*, those of S, P, As, Sb, Cl, Br, I, Si. In some cases it is not found necessary to use the Leyden jar but merely to cover the kathode with the powdered salt.
E. C. C. B.

233. *Absorption Spectra of some Compounds of Pyridine.* (Third Paper.) **J. E. Purvis.** (Cambridge Phil. Soc., Proc. 14. pp. 568–577, Nov. 20, 1908.) —An investigation of the absorption spectra of the 2, 3, 5- and the 3, 4, 5-trichloropyridines, the α- and γ-amidotetrachloropyridines and pentachloropyridine. The results obtained confirm and extend the observations of the author and Foster [Abstracts Nos. 777, 1428 (1908)] and of Baker and Baly [Abstract No. 244 (1908)]. It is found that the relative positions and the persistencies of the absorption bands of pyridine compounds are influenced by the type and by the spatial positions of the substituent atoms or groups of atoms.
E. C. C. B.

234. *Effect of Pressure upon Arc Spectra.* No. 2. *Copper,* λ4000–λ4600. **W. G. Duffield.** (Roy. Soc., Phil. Trans. Ser. A. 209. pp. 205–226, Dec. 14, 1908. Roy. Soc., Proc. Ser. A. 81. pp. 378–380, Nov. 9, 1908. Abstract.)—An extension of the author's previous work on the influence of pressure upon the spectrum of the electric arc [see Abstract No. 780 (1908)]. In this paper the spectrum of the copper arc is dealt with under pressure from 1 to 203 atmos. The apparatus was described in detail in the previous paper, and the results obtained may be summarised as follows: All the lines are broadened with increase of pressure, and though the broadening increases with the pressure it has not been determined whether there is a linear relation. The broadening is unsymmetrical, being greater on the red side, and is different for different lines. Two types of broadening have been noticed, for some lines become at first hazy and then are obliterated (series lines), while others, though broadened, remain well-defined lines (non-series lines). The intensity curves of the sharp lines under pressure are steeper towards the violet than those of the nebulous lines. Under pressure the most intense portion of every line is displaced in the direction of greater wave-length. This displacement is continuous and linear with the pressure, but the rates of increase with pressure are different for different lines. The lines belonging to the first and second subordinate series have greater displacements than the non-series lines. The displacements of the non-series lines appear to

vary at least as the third power and possibly as the sixth power of their wave-lengths. The mean displacement of the non-series lines is about 12·2 thousandths of an Ångström per atmo. None of the lines observed showed reversal. Considerable changes in the relative intensity of the lines were observed. Those of the first and second subordinate series vanish at about 70 atmos.; the former become hazy at low pressures, almost resembling bands, whilst the latter diminish in intensity without abnormal widening. Finally the brightness of the copper arc increases enormously with pressure. E. C. C. B.

235. *Infra-Red Line Spectra.* I. *Normal Wave-lengths to 27,000 Å.U.* **F. Paschen.** (Ann. d. Physik, 27. 3. pp. 537–570, Nov. 10, 1908.)—An account of the measurement of the infra-red lines in the spectra of He, O_2, H, A, Hg, Li, Na, and K. A plane grating with concave mirrors was employed, and a delicate thermopile and galvanometer. The vacuum tubes used in the case of the first five elements were made of glass or quartz, and were viewed end-on. The electrodes were hollow cylinders of Al, and in many cases the kathode end of the tube was immersed in a cooling bath. A high-voltage continuous current from accumulators was used. A considerable number of lines have been measured in the above spectra with a very great degree of accuracy. The values obtained by the author agree closely with those calculated from Ritz's equations, this being especially true in the cases of H and He where the new series prophesied by Ritz have now been observed. E. C. C. B.

236. *Zeeman-effect at Low Temperatures.* **W. Voigt.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 360–366, Dec. 28, 1908.)—This article deals with the experiments of K. Onnes and J. Becquerel on the Zeeman-effect at exceedingly low temperatures, and discusses the conclusions to be drawn from them. The author points out that, if we do not accept the difference between the inner and outer fields, then we must fall back upon the very complicated assumptions of Becquerel and Onnes, that the apparent (probably electromagnetic) mass of the electron is different parallel to the three axes of the crystal, and that the quasi-elastic forces in these directions are proportional to these masses. This would lead to the hypothesis of an immense number of different kinds of electrons, say of ellipsoidal form, which during their vibration remain parallel to themselves. As opposed to the difficulties of this hypothesis, the present author prefers the assumption of differences between the inside and outside magnetic fields as being much simpler. It is further noted that since negative electrons can vibrate about a stable position of rest only when inside a positive charge distributed over space, the assumption of vibrating *positive* electrons would entail the presence of distributed *negative* electricity. E. H. B.

237. *Studies in Luminescence.* **E. L. Nichols** and **E. Merritt.** X. *The Phenomena of Phosphorescence considered from the Standpoint of the Dissociation Theory.* **E. Merritt.** (Phys. Rev. 27. pp. 367–399, Nov., 1908.)—Wiedemann and Schmidt suggest that in solid solutions the effect of light and other exciting agents is to produce electrolytic dissociation of the active substance and that the light emitted during luminescence is to be explained as the result of the molecular vibrations which occur during the processes of dissociation or association of the ions. In the case of a homogeneous substance possessing only one phosphorescent band, this theory leads to a linear

relation between t and $I^{-\frac{1}{2}}$ during decay. The observed decay curve, however, is straight only for small values of t, after which it becomes concave to the t-axis, and then finally becomes again linear. The experimental data in no case contradict Becquerel's explanation that the form of the decay curve is due to the existence of two bands in the phosphorescence spectrum with different rates of decay. This explanation, however, takes no account of the hysteresis phenomenon or the effect of infra-red rays observed by the authors. The present paper deals with an extension of Wiedemann and Schmidt's theory, and it is shown that the results can be very satisfactorily explained by assuming unequal distribution of the ions. First, it is shown that a slight curvature of the decay curve will be produced by a lack of transparency in the phosphorescent substance, resulting in the absorption of either the exciting or emitted light, or both. This effect, however, can never be sufficient to account for the deviations from linearity which have been observed. Secondly, lack of uniformity in the distribution of the active material throughout the mass will cause a deviation similar to that observed. Such a lack of homogeneity is to be expected from the method of preparation of the phosphorescent substances. Thirdly, ionic diffusion will produce similar but more marked effects. An explanation of hysteresis may also be based upon the presence of ionic diffusion. Fourthly, the assumption of complex or grouped ions is shown to lead to a law of decay which agrees closely with experiment. This assumption also accounts satisfactorily for the dependence of the decay curve upon the duration of excitation and the previous history of the substance, and for the effect of exposure to the infra-red. E. C. C. B.

238. *Law of Optimum of Phosphorescence.* **G. Urbain.** (Comptes Rendus, 147. pp. 1472–1474, Dec. 28, 1908.)—This law may be stated as follows: In every binary phosphorescent system, of which the relative proportions of the constituents are varied, each band of phosphorescence passes through an optimum, and the optima of the different bands do not necessarily coincide, but always correspond to relatively feeble proportions of the phosphorescence-producing substance. de Gramont's results with the most sensitive rays of various elements [see Abstracts Nos. 1844 (1907) and 1421 (1908)] appear to depend on an analogous law. The principal facts relating to phosphorescence are briefly summarised as follows: (1) Pure bodies are not apparently phosphorescent; (2) in a binary system the optimum corresponds to a small proportion of the phosphorescence-producing substance, in the case of mixtures of the rare earths with chalk, the optimum corresponding to a small percentage of the rare earths; (3) the law of optimum applies equally to rare and common elements; (4) the colouration of the phosphorescence varies with the degree of dilution of the phosphorescence-producing body; and (5) the law of optimum becomes much more precise when applied to each radiation, rather than to the centres emitting phosphorescence. W. H. St.

239. *Motion of α-Particles.* **E. Riecke.** (Ann. d. Physik, 27. 4. pp. 797–818, Nov. 26, 1908.)—This is an attempt to follow the process of ionisation of air-molecules by α-particles quantitatively. Certain simplifying assumptions are made, such as that the speed is reduced uniformly, that the force between a molecule and an α-particle is due to a doublet of electrons within the molecule, and that this force, negligible beyond the sphere of molecular action, varies within that sphere inversely as the cube of the distance until the distance becomes comparable to the amplitude of the doublet, when it varies

inversely as the square. The limit of ionising action being $8{\cdot}86 \times 10^{-6}$ cm. for polonium, corresponding to a residual speed of $0{\cdot}82 \times 10^{9}$ cm./sec., the number of molecules ionised by each particle is 100,000. Each α-particle would have to fall through 620,000 volts to acquire its residual speed, and this voltage is considerably in excess of the 500 volts required to enable oxygen or nitrogen +-ions to exert an ionising action. The retarding action of the molecules ionised may be theoretically replaced by a contrary electrostatic field. But this would have to have a gradient of some 510,000 volts per cm. In order to produce ionisation, the α-particle has to approach the doublet to within $2{\cdot}6 \times 10^{-11}$ cm. The cosine of the angle by which both the α-particle and the molecule are deflected from their original path is not greater than 0·001. The energy transferred by the collision is $0{\cdot}78 \times 10^{-11}$. Since, according to H. A. Wilson [Abstract No. 825 (1902)], the energy required for ionisation is $0{\cdot}39 \times 10^{-11}$, these data would imply that only about half the energy transferred is spent on the process of ionisation. E. E. F.

240. *Sodium Emanation.* **G. Costanzo.** (Deutsch. Phys. Gesell., Verh. 10. 21. pp. 854–857, Nov. 15, 1908.)—On careful repetition of the experiments of Phillips [see Abstract No. 1289 (1908)], the author was unable to discover any trace of a discharging action of freshly cut sodium or an emanation from it. It accelerated neither the positive nor negative dissipation. If anything, it retarded the dissipation, probably by drying the supports of the charged body. The author suggests that Phillips' result is attributable to emanation accidentally absorbed by the sodium. E. E. F.

241. *Specific Radio-activity of Thorium and its Products.* **G. C. Ashman.** (Amer. Journ. Sci. 27. pp. 65–72, Jan., 1909.)—The author describes a convenient method for separating thorium and radiothorium from the other disintegration products of the element and brings forward additional evidence in support of the view that thorium emits an α-radiation on disintegrating. The specific activity of thorium is about 119—that is, about 11 per cent. of the activity of the same thorium when equilibrium amounts of its disintegration products are present. Of the remaining activity, 20 per cent. is due to radiothorium and 69 per cent. to ThX and subsequent products. The activity ascribed to Th itself is too much in excess of the activity of the ionium associated with Th in minerals to warrant the conclusion that the observed activity of Th is due wholly or largely to the presence of ionium. The conclusion of early investigators that Th itself is inactive was doubtless due to the fact that the methods used were not sufficiently refined to detect the low activity of the element free from its shortlived active products and other radio-active impurities. T. H. P.

242. *Radio-activity of Italian Gaseous Emanations.* **R. Nasini** and **M. G. Levi.** (Accad. Lincei, Atti, 17. pp. 551–553, Nov. 22, 1908.)—The radioactivity is given, together with the chemical composition in some cases, of thirteen natural gases from different parts of Italy. The most active is that from the Gastein thermal spring, which, although collected at least a week before being examined, gave a dispersion of 70,000 volts per hour, the next most active being from the spring of Abano (Padua), which contains H_2S and has a dispersion of 47,000 volts per hour after three days, equivalent to a saturation current of $868{\cdot}7 \times 10^{-12}$ amp. W. H. Sı.

REFERENCES.

243. *Simple Phosphoroscope.* **E. Meyer.** (Deutsch. Phys. Gesell., Verh. 10. 20. pp. 658–661, Oct. 30, 1908.)—This instrument, based on others previously described, combines the advantages of a mercury interrupter in the primary circuit of the induction coil with the possibility of a considerable variation in the interval between the excitation and observation of the phosphorescing substance. [Compare de Watteville, Abstract No. 1379 (1906); Lenard, Wied. Annalen, 46. p. 637 1892.] For details of the arrangement the original must be consulted. T. H. P.

244. *Quartz Compensator with Adjustable Sensibility.* **F. Bates.** (Bureau of Standards, Bull. 5. pp. 193–198, Nov., 1908.)—The arrangement described in a previous paper [Abstract No. 586 (1908)] has been criticised by O. Schönrock with regard to the importance of reflection and absorption in the small nicol which had not been taken into consideration [see Abstract No. 57 (1909)]. This is discussed, and it is concluded that it is entirely practicable to build a quartz compensating polariscope with adjustable sensibility, having a working range of polarisation angle from 3° to 15° with a negligible zero correction for all ordinary polarisations. G. E. A.

245. *Hartmann's Zonal Method of Lens Testing.* **H. Erfle.** (Zeitschr. Instrumentenk. 28. pp. 289–293, Oct., 1908. Communication from the optical works of C. A. Steinheil Sons.)—Describes a modification of the method by means of which the spherical aberration of quartz lenses may be directly determined for monochromatic light. L. H. W.

246. *Influence of Dispersion upon the difference of Path in the Lummer-Gehrcke Interference Spectroscope.* **O. v. Baeyer.** (Phys. Zeitschr. 9. pp. 831–834; Discussion, p. 834, Nov. 15, 1908. Paper read before the 80. Naturforscherversamml., Köln. Deutsch. Phys. Gesell., Verh. 10. 20. pp. 733–740, Oct. 30, 1908.)—In the simple theory for the above instrument no account is taken of the dispersion, and the author deals analytically with this influence in the present paper. The effect of the simple theory is to give somewhat too large wave-lengths. The corrected values are given in the paper. E. C. C. B.

247. *Polarisation of Diffused Light.* **N. D. Pilčikov [Piltschikoff].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. No. 4. pp. 165–167 [Physical Part], 1908.)—The author describes experiments, the results of which support his explanation of the disappearance of the polarisation of the sky during the solar eclipse of Aug. 30, 1905 [see Abstract No. 1358 (1906)]. T. H. P.

248. *Radio-activity of Rocks, &c., from the Island of Ischia.* **R. Nasini** and **M. G. Levi.** (Accad. Lincei, Atti, 17. pp. 432–434, Nov. 8, 1908.)—The radioactivity of a number of rocks and saline deposits from the island of Ischia has been examined in an endeavour to trace the origin of the intense activity, as found by Engler, of the water of Lake Ameno. None of the samples, however, showed any very considerable activity. W. H. St.

249. *Radio-activity of the Soil.* **F. Bordas.** (Comptes Rendus, 147. pp. 924–925, Nov. 16, 1908.)—Describes experiments on the radio-activity of the soil and rocks in the saltpetre mines of Chili and elsewhere in the district. Three regions were tested and gave results leading to the belief that the radio-activity observed is connected with the nitrate beds so extensive in that part of Chili. This point is to be further tested. E. H. B.

HEAT.

250. *Measurement of very Low Temperatures.* XXII. *The Thermo-element Gold-Silver at Liquid Hydrogen Temperatures.* **H. Kamerlingh Onnes** and **J. Clay.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 844–845, Dec. 28, 1908. Communication No. 107*b* from the Phys. Lab., Leiden.)—If one limb of the thermo-element Au-Ag is kept at 0° the e.m.f. at ordinary temperatures is about zero, but increases as its temperature is lowered. Thus between the temperatures $-258°$ to $-259°$ as read on a hydrogen thermometer the Au-Ag couple is about twice as sensitive as one of constantan-steel. The former couple is hence very suitable for accurate measurement of the lowest temperatures. W. C. S. P.

251. *Theory of Absorption in Gases.* **L. Bloch.** (Comptes Rendus, 147. pp. 1284–1286, Dec. 14, 1908.)—In Drude's form of the theory of absorption it is supposed that the electrons are subjected to a frictional force of which the coefficient is constant. In the case of metals, however, a satisfactory explanation is arrived at if the coefficient is taken as a function of the wave-length. Making this assumption, the result is outlined which is obtained by calculating the mean *vis viva* absorbed by the gas in 1 sec., and equating to the energy dissipated in the same time according to Poynting's theorem. There is an absence of experimental data with which to verify the formulæ found, but J. Becquerel's experiments on the Zeeman-effect in crystals show that the coefficient of friction varies sensibly as the square root of the absolute temperature. G. E. A.

252. *Methods of obtaining Cooling Curves.* **G. K. Burgess.** (Bureau of Standards, Bull. 5. pp. 199–225, Nov., 1908.)—The complete paper referred to in Abstract No. 1820 (1908). The various methods are discussed from the experimental and analytical standpoints. It is concluded that the time-temperature method is capable of giving the most comprehensive view of a transformation, whilst least information is given by the temperature-rate of change of temperature (θ, $d\theta/dt$) method. The inverse rate (θ, $dt/d\theta$) and the derived differential [θ, $(\theta - \theta')/\Delta\theta$] methods do not lend themselves to direct recording. The differential (θ, $\theta - \theta'$) method gives great range combined with sensitiveness and certainty, and by combining its indications with those of the time-temperature method (θ, t) it becomes the most complete method at our disposal. The author has used an autographic arrangement for recording $\theta - \theta'$ and θ on the same record. $\theta - \theta'$ is recorded directly by the boom of a 1·5 millivolt galvanometer, and alternately the instrument is connected through a 200-ohm resistance to the thermo-couple, which gives the temperature of the sample, θ, by means of a polarised relay actuated by the battery which depresses the galvanometer boom, causing it to make a mark on the record. F. R.

REFERENCE.

253. *On the Equation for the Propagation of Heat.* **E. Holmgren.** (Ark. för Mat. Astron. och. Fysik, Stockholm, Vol. 4. No. 18. pp. 1–28, 1908.)—A mathematical paper.

SOUND.

254. *Speed of Short Sound Waves from the Poulsen Arc.* **E. Dieckmann.** (Ann. d. Physik, 27. 5. pp. 1066–1080, Dec. 15, 1908. Physikal. Inst. d. Handelshochschule, Berlin.)—The author examined the short sound waves from the Poulsen arc by a plane reflection diffraction grating and pressure measurer. These were contained in a box, since the Poulsen arc runs in an atmosphere of illuminating gas. The chief results are as follows: (1) The sound speed in illuminating gas is constant (of the order 455 m. per sec. at 0° C.) up to frequencies of 800,000 per sec., *i.e.*, to wave-lengths of 0·59 mm. in the gas or 0·43 mm. in air. (2) The Poulsen arc is extremely convenient for researches on speeds of sounds near the upper limit of audibility on account of the constancy of the amplitude, the freedom from overtones, and the possibility of measuring the frequency electrically. (3) The diffraction grating seems most suitable for determinations of these short wave-lengths. E. H. B.

255. *Sound Waves from a Spark made Visible.* **M. Toepler.** (Ann. d. Physik, 27. 5. pp. 1043–1050, Dec. 15, 1908. Physikal. Inst. d. techn. Hochschule, Dresden, Oct. 20, 1908.)—Describes a new and simple method of making visible the sound waves in air from electric sparks. The sparks may be made by use of an induction machine and Leyden jars. In shunt with the "sound spark" is another, the "illuminating spark," and this latter is conveniently formed on the surface of a piece of wet chalk or other semi-conductor. The light from it passes through a lens, is refracted by the alternately compressed and rarefied shells of air in the sound waves, and is then viewed by the eye direct or, preferably, by a telescope. The interval between the occurrence of the sound spark and the illuminating spark can be varied by adjustment of the potential of the sound spark. This is most conveniently accomplished by varying the gaps for auxiliary sparks in series with it. The exact arrangement of the apparatus is explained by figures in the paper, which also has five excellent photographs of the results obtained. E. H. B.

256. *Sound Waves from Oscillatory Sparks.* **M. Toepler.** (Ann. d. Physik, 27. 5. pp. 1051–1058, Dec. 15, 1908. Physikal. Inst. d. techn. Hochschule, Dresden, Oct. 20, 1908.)—By the method described in the preceding Abstract the author examined the sound waves in air from oscillatory sparks, and found that the following details could be clearly seen: (1) The chief or initial wave, (2) a whole train of smaller waves, (3) the refracted image of the heated gases of the spark canal. Further examination showed that there was no constant speed of propagation of these sound waves, their speed depending on their intensity and diminishing with it. With a room temperature of 20–22° C. (and accordingly a normal sound speed of 343 m. per sec.) the observed speeds of the spark waves were from 462 down to 363 m. per sec. E. H. B.

REFERENCE.

257. *Recording Phonographic Waves.* **F. Hauser.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 143–150, Jan., 1908. 14th Report of the Phonogramm-Archivs-Kommission.)—Describes with diagrams the author's arrangement of levers and styles by which a record may be made of phonographic waves. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

258. *The Electromagnetic Field Surrounding a Cylinder, and the Theory of the Rainbow.* **P. Debye.** (Phys. Zeitschr. 9. pp. 775–778, Nov. 1, 1908. Deutsch. Phys. Gesell., Verh. 10. 20. pp. 741–749, Oct. 30, 1908. Paper read before the 80. Naturforscherversamml., Köln.)—This paper begins with references to earlier investigations on the subject, from Fresnel and Kirchhoff, whose method, according to the author, consisted of a harmonising of theoretical principles with experimental facts, and so on to the later researches of Rayleigh, Mie, and Ignatowsky. He considers the electromagnetic field round a perfectly reflecting cylinder, whose axis is taken for axis of z, with polar co-ordinates r, ϕ, and waves in the plane of xy polarised n direction z, the electric component in z being $Z=Z_0=e^{ikx}$...(1), with $k=\omega/c=2\pi/\lambda$, c being velocity of light, ω frequency of vibration, and λ wavelength. These waves meet the "disturbance field" whose z electric component is $-\Sigma e^{in\frac{\pi}{2}}\frac{J_n(ka)}{H_n(ka)}H_n(kr)\cos n\phi$...(2). In this expression J_n is the usual Bessel function. H_n in Nielsen's notation is Hankel's second cylindrical function, and the first term of the series is to be halved. This expression (2) is reduced by Fourier's method to—

$$Z=-\frac{1}{\pi}\int_{-\infty}^{\infty}d\beta e^{ika\cos\beta}K \quad \text{......................(3)}$$

where—

$$K=\int_{0}^{\infty}d\alpha\frac{H_\alpha(kr)}{H_\alpha(ka)}\cos(\alpha\phi)\cos(\alpha\beta) \quad \text{......................(4)}$$

and K is the "characteristic function," and depends exclusively on the properties of the cylinder, being independent of the incident wave. This may explain to the reader the author's method of approaching the problem. It would be impossible to do justice to his mathematics in an abstract, especially as it would require a reference to the author's Munich dissertation. He obtains for result—

$$Z=-\sqrt{\frac{a\cos\frac{\phi}{2}}{2r}}e^{-ik\left(r-2a\cos\frac{\phi}{2}\right)},$$

which agrees, he says, with what we should expect according to the laws of geometrical optics. Further, that when $\phi=\pi$—that is, on the opposite side of the cylinder to the source of the wave—a different formula has to be used which represents the phenomena of the rainbow at the limit of the shadow. There follows a discussion of the case of a dielectric cylinder which depends on an alteration of (4). The extension to the case of sphere instead of cylinder presents, the author says, no difficulties. S. H. B.

259. *Radiation of a Point Charge.* **M. Laue.** (Deutsch. Phys. Gesell., Verh. 10. 21. pp. 838–844, Nov. 15, 1908; Ann. d. Physik, 28. 2. pp. 436–442, Feb. 4, 1909.)—Treats the radiation of an accelerated point charge on the principle of relativity. The force experienced by the charge in consequence of radiation is the same as that experienced by Abraham's rigid electron, and the limits of quasi-stationary motion are also the same [Abstract No. 2147 (1904)]. The amount of energy radiated per unit of time is the same in a stationary and in a moving system. The principle of relativity leads to the same results as Abraham's theory, but by simpler methods. But whereas on the older theory a uniform motion of a charged body requires a force to compensate for the radiation, on the relativity theory all the energy radiated is derived from the source of radiation. An extended source of light exerts a pressure upon an absorbing body, but not when the body is homogeneous, isotropic, and limited by convex surfaces only. E. E. F.

260. *Foundations of Electrodynamics.* **W. Ritz.** (Phys. Zeitschr. 9. pp. 903–907, Dec., 15, 1908.)—A re-statement of the principles advanced in a previous paper [Abstract No. 886 (1908)]. The Jeans-Lorentz theory of black radiation suffers under a defect. The expression for the electric and magnetic forces is too general, and contradicts the formulæ for the retarded potentials, which every physically admissible solution of the fundamental equations must satisfy. This limitation greatly reduces the number of co-ordinates of the free ether, and the agreement between theory and fact is impaired by the circumstance that these co-ordinates, infinite in number, tend to absorb the whole energy of the system. The complete expression of the laws of radiation cannot be found in Maxwell-Lorentz differential equations, but in the elementary actions resulting from the introduction of retarded potentials into Lorentz's expressions for the ponderomotor forces. The difficulties of the theory of black radiation accentuated by Lorentz do not necessitate the introduction of an energy-time atom, as suggested by Planck, but the adoption of a minimum principle in the sense of the classical mechanics, so that a finite number of data suffices to determine the motion of a system of electrons for all time. The "ether" thus becomes nothing but an absolute system of co-ordinates, and a mathematical construction which introduces an infinite number of constants into the formulæ. Experience tends to eliminate the conception of the ether altogether as a useless intermediary framework, and with it Maxwell's description of electromagnetic phenomena by differential equations, which are insufficiently supported by experiment. E. E. F.

261. *Fundamental Electrical Units.* **F. A. Wolff.** (Bureau of Standards, Bull. 5. pp. 243–260, Nov., 1908. Paper read before the Amer. Phys. Soc. and the Amer. Electrochem. Soc., April, 1908.)—Gives details of the principles involved in the selection and definition of the fundamental electrical units for international adoption. The author considers that the choice of fundamental units depends on (1) accuracy of reproduction from specification, (2) concreteness, (3) ease of reproduction. The standard cell is given preference over the silver voltameter. F. E. S.

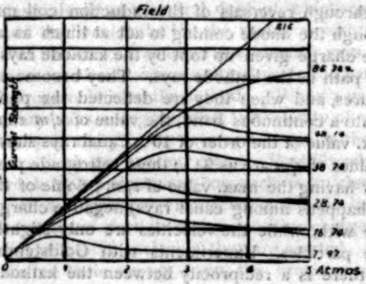
262. *On the supposed Excess of Negative Electrification produced by Spraying.* **J. C. Pomeroy.** (Phys. Rev. 27. pp. 492–501, Dec., 1908.)—Eve has found that when water is broken up into a fine spray the negative ions are in excess of the positive in the ratio 4 to 3 [see Abstract No. 2080 (1907)]. The author has conducted a number of experiments to find an explanation of the discrepancy. A current of air produced by blowers run by motor was passed through a glass-wool filter into a Gouy sprayer and then into the testing chamber of an electroscope. After a few minutes the current was stopped, the electroscope quickly charged, and the fall of the leaf timed. A larger percentage of negative ions than of the positive was removed during the first quarter of a minute, indicating a somewhat greater velocity for the former. The air and spray entering the electroscope was shown to contain an excess of negative ions and it was thought possible that positive electricity was carried out of the spray by the heavier drops. An insulated metal pan connected to an electrometer indicated a steadily increasing positive charge when placed so as to catch this heavier spray. That this was not produced by splashing was shown by the fact that practically the same rate of motion of the electrometer was produced when the pan contained water. Air from the sprayer was next passed directly into a testing vessel consisting of three portions, each one insulated from the others and containing a plug of glass-wool at the far end. With continuous spraying, Section I. indicated an excess of positive electrification and each of the other two sections an excess of negative electrification. On connecting the three sections the electrometer indicated no charge although the spraying was continued for over 20 min., thus proving that the mixed spray and air on leaving the sprayer shows no excess of negative electrification. It occurred to the author that all the water particles, coarse or fine, might carry positive charges and the negative ions might be clusters of air molecules. He therefore passed the air current over a layer of sulphuric acid and found that whereas the negative ionisation was not affected by the presence of the acid, fully one-half of the positive ions were removed by the water absorbed by the acid. Observations on the dew-point after the current has passed through the vessel containing acid confirm the above results and show that negative charges cannot be associated with spray particles to anything like the same extent as positive ones. The author quotes the experiments of C. T. R. Wilson on the condensing powers of the positive and negative ions in adiabatic expansions in support of these views. W. C. S. P.

DISCHARGE AND OSCILLATIONS.

263. *Ionisation of Gases at High Pressures.* **H. A. Erikson.** (Phys. Rev. 27. pp. 478–491, Dec., 1908. Paper read before the Amer. Physical Soc.)—An iron cylinder having a hole along its axis was used to contain the gas under pressure. The radio-active salt was contained in a small brass thimble which could be let into the side of the cylinder. The upper portion of the hole was lined with brass and served as ionisation chamber. The electrodes were in the form of cylinders concentric with the hole. The inner cylinder and the lining form one electrode and are connected to the iron cylinder, the other cylinder and a central wire being connected and forming the other electrode which was insulated. The tube containing the radio-active salt could be quickly withdrawn at any instant. The current in all cases was determined by the time taken for the leaf of an electroscope, connected to the insulated electrode, to be deflected by a certain amount. The capacity of the electrode system being constant, the ionisation current is inversely proportional to the time. It was found that as the air or CO_2 increases in density the ionisation current produced with any given potential attains a maximum value and then diminishes. The higher the potential the

greater is the value of the density, given the max. current. At potentials higher than 100 volts the current, beyond the maximum, is an inverse linear function of the density. At high pressures such as 400 atmos. it requires about 14 sec. before the number of ions in air reaches a steady state, the potential being 1,000 volts. When the rays have ceased to act the ions of a gas linger for a time increasing with increase in the density of the gas. It was also found that the natural conductivity of CO$_2$ gas increases as the gas approaches the liquefying pressure. On liquefaction the conductivity suddenly changes to double its former value. W. C. S. P.

264. *Effect of Pressure on Ionisation.* **E. Rothé.** (Comptes Rendus, 147. pp. 1279–1281, Dec. 14, 1908.)—In continuation of a previous research [see Abstract No. 2004 (1908)] it is found that for a given value of field there is a pressure for which the current intensity is a maximum, the variation of current with pressure in a constant field being shown in the curves given in which the abscissæ are pressures. G. E. A.



265. *Photo-electric Investigations with Colour Cells.* **A. Goldmann.** (Ann. d. Physik, 27. 3. pp. 449–536, Nov. 10, 1908.)—Since the investigation of the ionising action of different kinds of radiation in gases a similar effect has been sought in solutions. Cunningham's results were uncertain; Regner's investigations gave a negative and those of Nichols and Merritt a positive result, viz., that visible radiation had an ionising action on fluorescent substances. The question of the change of electric conductivity of a fluorescent colour solution during radiation was taken up, and it was found that: (1) Radiation of the colour solution causes no measurable change of resistance if the electrodes are screened. (2) Radiation of the layer of colouring matter next to the electrode produces an e.m.f. With a closed circuit a photo-electric current is set up. (3) With kathodic polarisation of the electrode which is to receive the radiation the current caused by radiation is in the same direction as the polarising current and strengthens it. The apparent resistance of the cell is thus decreased. (4) Under certain circumstances an apparent increase of resistance may take place. Photo-electric currents and potentials in colour solutions are next investigated, and it follows from the measurements that light separates in unit of time a constant number of charges which is proportional to the area illuminated and to the intensity of the light. This result forms the basis for the numerical treatment of various photo-electric measurements, and enables their reciprocal relations to be fixed. As an auxiliary hypothesis it was assumed that the separation of charges takes place through the breaking away of negative electrons from the molecular group with certain initial velocities. This method of representation bridges the gap between photo-electric processes in metals, in gases, and *in vacuo* (Hallwachs-Lenard effect) and the photo-electric phenomena in colour cells, in cells with sensitive electrodes dipping into electrolytes (Becquerel actinometers) and others, and as regards colour solutions, it connects together the various experimental, and hitherto apparently contradictory, results. G. E. A.

266. *Positive Rays.* **J. J. Thomson.** (Phil. Mag. 16. pp. 657–691, Oct., 1908.)—Mixed with ordinary kathode rays are others, not appreciably deflected by weak magnetic fields. Goldstein finds [Abstract No. 868 (1908)] five kinds of such rays; some of these are deflected and carry positive charges, borne with high velocities against the direction of the electric force. These positive rays really come from the kathode and are not canal rays from the perforated anode (either through reversals of the induction coil making the anode a kathode or through the anode coming to act at times as a kathode in virtue of the negative charge given up to it by the kathode rays); and they follow much the same path as the kathode rays. They become exceedingly faint at very low pressures, and when they are deflected the phosphorescence spot is drawn out into a continuous band, the value of e/m ranging continuously from 0 to a max. value of the order of 10^4. Canal rays show two types of rays, in which the values of e/m are as 2 : 1; these retrograde positive rays coincide with canal rays having the max. value of e/m. Some of the retrograde rays carry (as also happens among canal rays) negative charges, and the masses are comparable with, while the velocities are only slightly less than, those of the positive particles. Experiments with Goldstein's double kathodes indicated that there is a reciprocity between the kathode and the positive rays; the former are due to the impact of positive ions at or near the kathode, the latter to the impact of the corpuscles at some distance from the kathode; unless the lines of force from the kathode are straight the moving corpuscles will not follow them precisely and the returning positive particles produced by it do not impinge upon the kathode at the original point. Villard's magneto-kathodic rays, in the direction of the lines of magnetic force, behave like ions subject to electric and magnetic forces and to a resistance to motion proportional to their velocity; but they do not seem to carry electric charges; which may perhaps be due to the air round the Faraday cylinder being made a good conductor by the rays. The velocity of the retrograde positive rays and of canal rays being much the same (about 2×10^8 cm./sec.) is a remarkable result; but we can only ascertain the velocities within a very limited range of pressures. The positive particles seem to have been discharged and then recharged positively by losing a corpuscle by collision after passing through the perforated electrode. Some of the canal rays clearly are uncharged during a portion of their path near the kathode; they have picked up a negative corpuscle which has not appreciably altered their mass or their velocity: they are thus uncharged; and thereafter they are ionised by collision, lose a negatively charged corpuscle, and again become positively charged. Some of them gather an additional negative corpuscle and become negatively charged for the time; the retrograde positive rays seem to originate in an analogous manner. Distinguish between positive ions in an ordinary ionised gas and the positive ions, possessed of very great kinetic energy, found in canal rays. The former can combine into positively charged aggregates; the latter cannot, for they correspond to gases at a temperature of many hundred thousand degrees abs., and would be little likely to combine with uncharged molecules, the less so the greater the mass of these. When ionisation is steady, under a constant source of ionisation, we find a considerable number of ions for which *e/m* is 10^4 and some for which *e/m* is from $10^4/25$ to $10^4/44$ for hydrogen; while with oxygen the number of ions with masses comparable to those of hydrogen atoms is too small to be detected, and the majority of the ions have masses comparable to those of molecules of oxygen, not aggregates of molecules. The different behaviour of ions of different mass would enable a very delicate analysis of a gas to be effected. The positive ions in an ionisation chamber seem to be moving more rapidly than the negative. With canal rays, on the other hand, the values of *e/m* are the same in hydrogen and oxygen. The particles composing the canal rays are the same from whatever source they may be derived; there are in oxygen no particles having masses comparable with those of the ions in oxygen. Probably, below a certain relative velocity, a positive ion and a corpuscle coalesce, forming a neutral doublet, which cannot form part of the canal rays; and the heavier the ion the sooner would this coalescence occur. The only ions which can be observed in canal rays are those of H and He. This coalescence should occur quite close to the kathode or, if this be perforated, in the region behind the kathode. When a gas is ionised by kathode rays secondary rays are generated, the velocity of which does not depend on the velocity of the primary rays and is much the same whether the secondary rays are from gas or from metal. Possibly what is driven off from a molecule struck by a primary-ray corpuscle is an electrically neutral doublet, consisting of a negatively electrified corpuscle in rapid rotation round a much more massive particle with a positive charge, such doublets being the same from whatever molecule they are ejected. The secondary rays then would derive their energy from the break-up of this rotating doublet, and *e/m* would be the same in the canal rays produced from different gases. Such break-up might occur under the influence of a passing corpuscle acting as a comet and liberating the rotating component by neutralising the attraction in the doublet. Preliminary experimental results suggest the existence of such neutral doublets; a field which would stop negative corpuscles allows the passage of something which thereafter gives rise to ionisation. In these experiments ultra-violet light from the luminous discharge in the main tube and soft Röntgen rays produced by the slowly moving primary kathode rays were found to produce no effect; and other possible causes of the ionisation observed were eliminated. Still the effects might be due to some very easily absorbed kind of radiation or to the diffusion of very slowly moving ions. There are reasons for thinking that doublets are also produced when ionisation is produced by positive rays. When a gas is ionised by α-rays the number of ions produced by each α-particle is very great, but the distribution of them is very irregular as the α-particles are few; and it will require a more intense field to saturate a gas ionised by α-particles than a gas where the total ionisation is the same but the ionisation is uniformly distributed through the gas. A. D.

267. *Positive Rays.* **J. Trowbridge.** (Phil. Mag. 16. pp. 697–702, Oct., 1908.)—In a spark-discharge circuit containing condenser, self-inductance, and an exhausted tube with perforated kathode, the positive canal rays, of different velocities, may be made to spread out in the form of a cone of which the apex is the narrow orifice in the kathode; while under the influence of a magnetic field these rays whirl round in the field, and the whirls present an electrodynamic attraction for one another. A. D.

268. *Positive Rays.* **W. Wien.** (Ann. d. Physik, 27. 5. pp. 1025–1042, Dec. 15, 1908.)—The positive rays known as canal rays are distinguished from the negative kathode rays by the fact that in a magnetic field they are not equally deflected. The greatest deflection is the same as that which a positive atom of the gas would undergo with the velocity which it would attain under acceleration of the full discharge-potential. Various hypotheses have been made to explain this unequal deflection, and the author has again examined the behaviour of the particles under the action of a magnetic field, and has come to the following conclusions as the result of his experiments: The unequal magnetic deflection of the canal rays depends on the fact that the positive ions remain for a varying time in the discharged condition, and are ever anew becoming charged and discharged. This state of affairs brings on a condition of equilibrium which, if disturbed, is again renewed. In high vacua there is exhibited, in the case of canal rays in air, an actual decrease of the capability of being influenced magnetically, without any other apparent change of the circumstances. From the observations made it appears that the current is as much weakened by a magnetic field acting directly on the withdrawn rays at a distant part of the tube as at a nearer spot. Hence it follows that the greater weakening of the light at greater distance *cannot* be explained on the hypothesis that the quicker rays, which send out more light, are deflected out of the bundle. In a bundle of canal rays only the transported quantity of electricity is diminished by a magnetic field, and scarcely at all the light emission. The emission of light then depends on the particles which are in a less degree capable of being influenced magnetically, and thus either on those which are neutral or those which are charged only for a short time. If the bundle of canal rays has traversed a longer path behind the magnetic field, the light emission decreases therefore in the same way through the action of the magnetic field as the transported electricity. The distance which the bundle must traverse after the magnetic field till the weakening of the current corresponds to that of the emitted light, increases with the discharge potential. J. J. S.

269. *Nature of the Streamers in the Electric Spark.* **S. R. Milner.** (Roy. Soc., Phil. Trans. Ser. A. 209. pp. 71–87, Nov. 16, 1908. Roy. Soc., Proc. Ser. A. 81. pp. 299–300, Sept. 11, 1908. Abstract.)—An investigation of the electric spark between metallic electrodes with the aid of a revolving mirror. The first part of the investigation is concerned with an examination of the spark with the rotating mirror, but without any spectroscopic apparatus. Two important observations are recorded as a result of these first experiments, namely, that the streamers start from the kathode, and also that they are composed of charged particles of metallic vapour. Their direction of travel tends to become reversed when the electric field of force changes its direction. The second part is concerned with the duration and velocity of the streamers, and was carried out with the aid of spectroscopic attachment set at an angle of 45° with the horizontal so that a series of monochromatic images of the spark in echelon was obtained in the focal plane of the camera. The values obtained for the duration of the lines vary for the different classes of lines with the same element, the duration of the arc lines being from four to six times those of the spark lines. In the case of the elements Al, Bi, Pb, Sb, Sn the spark line can be divided into two classes, one class having half the duration of the other. The lines of the first class are very sensitive to self-inductance, disappearing when more than a very small amount is introduced. In the condensed spark without inductance they are usually very bright. The velocities of the streamers appear to be the same for all the lines of an element, and not to vary for different lines as has been suggested by Schuster and Hemsalech and others [see Abstract No. 1066 (1900)].

E. C. C. B.

270. *Reflection and Secondary Radiation of Slow Kathode Rays.* **O. v. Baeyer.** (Deutsch. Phys. Gesell., Verh. 10. 24. pp. 958–967, Dec. 30, 1908. Paper read before the 80. Naturforscherversamml., Köln, Sept. 23, 1908.)—The author has already shown that slow kathode rays which proceed from a glowing oxide kathode, when they fall on metal surfaces in a space free from electric forces, give rise to a considerable diffuse kathode radiation. The reflection was measured in the experiments described in the present paper by a method of which the principle is as follows: A bundle of kathode rays, which first of all falls on the reflector to be examined, is next collected by a hollow cylinder, with which practically no reflection occurs. If the current which flows away from the reflector with respect to the hollow cylinder is dispensed with, then the reflecting power can be calculated from the relation between the two currents. In agreement with earlier investigations it was proved that with kathode rays which proceed from glowing oxide kathodes with primary velocities of 5 volts and upwards, there is a considerable reflection with respect to secondary radiation at metal plates. The reflection falls off with increasing primary velocity, the secondary radiation increases. The secondary radiation is so intense that already with about 30 volts primary velocity as many electrons leave the plate as fall upon it. The nature of the surface of the reflector has an essential influence on the phenomenon, whilst an influence due to the material cannot be proved with certainty. Soot and platinum black show reflection and secondary radiation in quite a small degree only.

J. J. S.

271. *Momentum Effects in Electric Discharge: Effect of an Angle in a Conductor.* **F. E. Nipher.** (Science, 28. pp. 93–94, July 17, 1908. Abstract of paper read before the Amer. Phil. Soc., Philadelphia; addendum in Science, 28. pp. 807–808, Dec. 4, 1908.)—The author gives the preliminary results of his experiments in the first article; in the second, it is stated that the methods have been modified and additional results reached. The second article is reproduced nearly in full so as to give the author's own words in view of the fact that this important communication is already in as brief a form as is possible: "In all of the work thus far, an 8-plate static machine has been used. Sparks from 4 to 8 in. long are taken from the two terminals into parallel conductors having high resistance. These resistances consist of long, thin strips of cloth moistened with salt solution. These lines spark to ground contacts, which are about 50 ft. apart, in the yard outside. A thin wire is bent into a series of sharp right angles. This wire may be looped into either the positive or the negative line. Photographic plates enclosed in hard-rubber holders are placed at these angles. Some of them are exposed to the wire on the ground side of the angle, and some on the machine side. Their distance must be so adjusted that they give symmetrical results when the spark discharge around the angles is reversed. With the negative discharge the plates on the ground side of the angles are much more strongly fogged than those on the machine side. Negative electrons having a mass of about 1/1000 of that of the hydrogen atom leave the wire at the angle, because they cannot turn the corner. They pass on through the cover of the hard-rubber holder, which may be $\frac{1}{16}$ in. thick, and fog the plate, which is developed in the ordinary way. These particles have momentum. They have energy of motion. They are a component of matter, as is well established by radio-active phenomena and by well-known electrical experiments. When the wire having these angles is looped into the line from the positive side of the machine this effect is also observed, but it is very much feebler. With a cover to the holders $\frac{1}{16}$ in. thick, 9,000 spark discharges in the positive line produce about the same intensity of image as is obtained with a single spark in the negative line. And here the effect is vastly stronger on the machine side of the angle than on the ground side. The negative electrons are therefore doing the work in the positive line also. They flow through this line from the ground to the machine. But they are not forced in under pressure, as they are forced out from the machine on the negative line. In order to obtain the results here described electrical oscillations must be prevented. This is attained by means of the moistened strips of cloth. When this has been accomplished the sparks are large and brilliant at the negative end in both positive and negative lines, and thin out towards the positive end. The negative terminals are large spheres of about 10 cm. diam. The positive terminals are small knobs, of about 1 cm. diam. While on the large spheres the electrons repel each other. But when they start into motion across the spark-gap, they attract each other electromagnetically. This appears to be the reason why the spark thins out as the electrons proceed in their motion across the spark-gap. A 'fat' spark is a sure indication of an oscillating discharge. The fact that sharp shadow pictures are formed of any thin object like a glass slide lying on the photographic film under the wire shows very clearly that these effects are due to a kathode discharge. Whether or not X-ray effects are also involved is still an open question. Arrangements are now being made to place the angle wire in a vacuum tube. This may perhaps render these momentum effects visible." [Compare Cantor, see next Abstract.] L. H. W.

272. *New Effect of Electric Current.* **M. Cantor.** (Phys. Zeitschr. 9. pp. 887–888; Discussion, p. 888, Dec. 1, 1908. Paper read before the 80. Naturforscherversamml., Köln.)—If one takes the view that the electric current in metallic conductors is concerned with the translation of particles possessing inertia, then it is natural to expect that an experimental evidence of these particles might be obtained near a point at which the current suffered a sudden change in direction. Such an experimental confirmation the author has actually obtained. A glass plate possessing one of the sharpest possible corners was coated with an extremely thin film of metal. Gold and platinum were used by the burning-in process, also silver by chemical deposition. The mirror of metal thus obtained was so thin as to be quite transparent. The metal film could be connected to a battery of 70 volts and then allowed a current of a few milliamps. to pass. Two or 3 mm. from the sharp corner in the metal film was an insulated wire connected to a Braun voltmeter charged to a few hundred volts. When the current was put on in the metallic film, a speedy discharge of the voltmeter occurred. Whether the charge were positive or negative it was discharged, but the discharge of the positive seemed quicker. A photographic plate 2 mm. from the active corner, after an exposure of 80 min. while the current flowed in the gold film, gave an intense negative. In the *discussion*, the **Author** remarked that he failed to obtain the phenomena with the *thinnest beaten* gold. [See also Nipher, preceding Abstract.] E. H. B.

273. *Separation of Radiation.* **V. K. Lebedinskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. No. 4. pp. 187–190 [Physical Part], 1908.)—The secondary circuit of an induction coil was closed on a leyden jar, in parallel with which was a spark aperture, the brass electrodes being one spherical and the other pointed. When the pointed electrode is made positive and the spark is sufficiently long, the latter is extinguished by radium rays. But if these rays traverse a layer of lead about 1 cm. in thickness, they then ignite the spark—that is, render it more frequent. This igniting action is probably due to the γ-rays. The fact that the extinguishing action of radium is deviated by a magnet pole confirms the view that this action is caused by the β-rays. Also, if the pointed electrode is positive, the light from a voltaic arc exercises a marked extinguishing action. This is the case when the light from the arc is passed through a wide slit. When the latter is continuously narrowed, at first jumping of the spark is observed, then the spark becomes more intense, and finally, when the slit is closed altogether, the spark resumes its normal condition. If, when the light from the arc is exercising its extinguishing action on the spark, it is passed through mica, faint ignition is observed, which increases in intensity if the mica is brought to within 2–3 cm. from the spark. [See also Abstract No. 1805 (1908).] T. H. P.

274. *Action of Ultra-violet Light on a Spark Discharge.* **B. Marzetti.** (Accad. Lincei, Atti, 17. pp. 576–579, Nov. 22, 1908.)—Experiments on the discharge between spheres and discs of iron or zinc, using in the former case the voltaic arc and in the latter a Nernst lamp as source of ultra-violet rays, show that the action of the rays, whether helping or impeding, is exerted on the negative pole only, any apparent action on the positive pole being due to reflection or diffusion from one pole to the other. [See Abstract No. 2959 (1904).] W. H. St.

275. *Sparking Potential of two Spark-gaps in Series.* **P. Nordmeyer.** (Phys. Zeitschr. 9. pp. 835–844, Nov. 15, 1908. Paper read before the 80. Naturforscherversamml., Köln. Deutsch. Phys. Gesell., Verh. 10. 20. pp. 768–784, Oct. 30, 1908.)—By means of a Holtz machine, a Leyden jar, the outside coating of which is earthed, is slowly charged up until it discharges itself to earth through two spark-gaps in series. An electrometer across the two gaps measures the sparking potential. The connection between the two gaps is insulated. In this arrangement it is found that the total sparking potential depends only on the potential required to spark across the gap I., which is connected to the inside of the Leyden jar. But the presence of the gap II., one side of which is connected to earth, increases this potential by a definite amount, which depends upon the capacity of the insulated portion between the two gaps. The greater this capacity is, the less is the increase in this potential. If the length of gap I. is fixed, as gap II. increases in length the total sparking potential increases in a step-wise manner, remaining stationary now and then for a considerable increase of length of gap II. But the total sparking potential is never greater than the sum of the sparking potentials of the two gaps, taken separately, and is very often considerably less than the sparking potential of a single gap equal in length to the sum of the two gaps. If, however, both gaps are subject to ultra-violet radiation, the total sparking potential is always equal to the sum of the sparking potentials of the gaps. The same is true when gap I. is illuminated, but not when gap II. is illuminated. The author's results also show that the sparking potential for a single gap, one side of which is earthed, is the same whether the gap is subject to ultra-violet radiation or not, provided the charging takes place slowly enough. A lengthy discussion of these observations follows, and they are fully explained on the basis of J. J. Thomson's theory of the spark-discharge. T. P. B.

276. *Damping due to Spark in a closed Oscillatory Circuit.* **E. Jacob.** (Phys. Zeitschr. 10. pp. 22–28, Jan. 1, 1909. Inst. f. techn. Physik, Jena.)—The period of oscillation of the circuit is $1{\cdot}276 \times 10^{-6}$ sec. An induction coil is used for charging the capacity. The form of the oscillation is obtained by photograph from an oscillograph connected in the circuit. With the spark-gap in the circuit the oscillogram gives the total damping. The spark-gap is then closed and the condenser charged and discharged through the circuit by means of a switch. The resulting oscillogram gives the damping due to condenser-losses and resistance of wires, hence the damping due to the spark is obtained. Length of spark is never more than 2·5 mm. Curves and tables of results show how (1) in the course of a discharge the spark damping at first falls slightly and then increases quickly as the oscillation dies away; (2) if the length of spark is constant the spark-damping at first falls quickly with increasing current and then rises slightly; (3) the greater the heat-conductivity of the material of the electrodes and of the surrounding gas, the greater is the spark-damping; (4) subdividing the spark-gap increases the damping. The author explains these results by regarding the spark as a high-frequency alternating arc. T. P. B.

277. *The Discharge of a Condenser.* **A. Léauté.** (Comptes Rendus, 147. pp. 1394–1397, Dec. 21, 1908.)—The formula $T = 2\pi\sqrt{CL}$ given by Kelvin for the period T of the oscillatory current produced by the discharge of a condenser of capacity C through a negligible resistance of self-induction L, supposes that the capacity of the circuit which joins the two armatures is zero. But coils of self-induction when they have many layers of wire possess a capacity which must be taken into account, and which gives rise to the striæ observed by Hemsalech in the induction sparks. The author investigates mathematically the formula which must be employed when coils with many layers are in the discharge circuit. He finds that the discharge current of a condenser through a coil with two layers may be considered as formed by the superposition of an infinite number of sinusoidal currents whose amplitude tends towards zero with the period. If the frequency of the least rapid oscillation is calculated on this theory and compared with that deduced from Kelvin's formula, it is shown that in spite of the difference of the formulæ employed the numerical results arrived at are very nearly the same. Moreover, calculation is able to predict the presence of striæ in the induction sparks, and gives for their number and their distance apart figures which agree with those found experimentally by Hemsalech. J. J. S.

278. *Increased Resistance of Solenoids for High-frequency Oscillations.* **F. Rusch.** (Jahrbuch d. Drahtlosen Telegraphie, 1. 4. pp. 496–522, Sept., 1908.)—A lengthy theoretical and experimental investigation, the main result of which is that in order to keep down the increase of resistance to its lowest value the solenoid should have only *a single layer* of wire; for the resistance increases considerably with increase in the depth of the wound portion, and appears to tend towards infinity for an infinite number of layers. Experimental and calculated results agree quite well up to frequencies about

10,000 ∾ per sec., but above this value larger differences occur. For further information and the numerous curves the original should be referred to. **L. H. W.**

ELECTRICAL PROPERTIES AND INSTRUMENTS.

279. *Electric Resistance of Alkali Metals, Gallium and Tellurium.* **A. Guntz and W. Broniewski.** (Comptes Rendus, 147. pp. 1474–1477, Dec. 28, 1908.)—The specific resistance of the metals has been determined by placing them in a capillary U-tube, and comparing their resistances with that of pure Hg at temperatures ranging from −187° to 99·8° C. The specific resistances for Cs, Rb, K, Na, and Li are 19·30, 12·80, 7·01, 4·80, and 8·55 respectively at 0°, and for other temperatures the resistance agrees fairly well with that calculated from the formula : *resistance* = (2F + T) × const., where F is the absolute temperature of fusion and T the absolute temperature of the body. In the case of Na and Li the resistance found at −187° is lower than that calculated, indicating molecular association at this temperature. The specific resistance of Ga is 53·4 at 0°, rises to 57·0 at 18·6°, and then decreases, the element melting at 29°. The specific resistance of the liquid metal, supercooled to 18·6°, is 28·0. The resistance of a sample of Te having $R_0 = 0{\cdot}102$ ohm reached a maximum at about 50°, and then diminished till the metal melted, when it slightly increased again, confirming the view of Exner that the abnormal resistance of Te is due to the variable size of the crystals formed in the mass under different conditions and not to any metalloidal modification. **W. H. St.**

280. *Electrical Conductivity of Magnesium-Lead Alloys.* **N. J. Stepanow.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. p. 1151, 1907. Zeitschr. Anorg. Chem. 60. 3. pp. 209–229, Dec. 8, 1908.)—The author gives a brief review of the work done on the electrical conductivity of alloys in general. On account of the extreme brittleness of these alloys, the test specimens were prepared by sucking the molten alloys into glass tubes in an atmosphere of coal-gas. The conductivity-concentration diagram agrees substantially with the thermal equilibrium diagram and microstructure [see Abstracts Nos. 889 and 1961 (1905)]. The curves fall to a minimum corresponding to the compound Mg_2Pb, but a discontinuity in the curve between Mg_2Pb and the Mg ordinates indicates the formation of solid solutions of Pb in Mg, a formation not indicated by thermal analysis. **F. C. A. H. L.**

281. *Influence of Pressure on Electrical Resistance of Selenium and Silver Sulphide.* **F. Montén.** (Ark. för. Mat. Astron. och Fysik, Stockholm, Vol. 4. No. 31. pp. 1–6, 1908.)—Marc holds that grey crystalline selenium consists of two different allotropes, termed by him Se_A and Se_B, and that the variations in resistance are mainly due to a shifting of the equilibrium ratio of the two substances. If this is the case, it is probable that the two forms have different specific volumes, and that a shifting of the equilibrium ratio, and hence an alteration of the conductivity, should be capable of being effected by hydrostatic pressure. Experiments in which pressures up to 3,000 atmos. were employed show that this actually occurs. The pressure was applied in the apparatus used by E. Lisell for his investigations upon the effect of pressure upon the resistivity of metals, and was calculated from his results [Dissertation Upsala Univ., 1908 ; in this it was shown that a manganin wire exposed to hydrostatic pressure undergoes changes in pressure which are directly

proportional to the pressure, the pressure-coefficient (λ) being given as $\lambda = 0{\cdot}00000221$ per atmo.]. The change in resistance is very small at even the high pressures, and hence a null method is used. It is found that the resistance of selenium decreases rapidly as the pressure increases, so that at 3,000 atmos. the resistance is only 0·005 to 0·02 of its original value. The curves of resistance with increasing and falling pressure respectively do not fall together, the former curve lying above the latter at pressures over 800 atmos., but crossing at this pressure and lying below it for lower pressures. There is thus a sort of hysteresis. At the end of the exposure to 3,000 atmos. the resistance on reduction to 1 atmo. pressure is at first only 0·2 to 0·5 of its original value, but the resistance gradually recovers. The values found are shown in the following table :—

Pressure	1 atm.	500	1,000	1,500	2,000	2,500	3,000
Room temp. resistance......	100	62·4	39·1	25·1	16·8	11·01	7·65
0° resistance	100	60·7	36·7	22·5	14·1	8·97	5·89

Reference is made to F. C. Brown [Abstract No. 1042 (1905)]. As regards silver sulphide, the resistance is found to follow Königsberger and Reichenheim's general equation for oxides and sulphides. L. H. W.

282. *Action of Röntgen Radiation on the Electric Resistance of Selenium.* **G. Athanasiadis.** (Ann. d. Physik, 27. 4. pp. 890–896, Nov. 26, 1908. Phys. Lab., Univ. of Athens, Aug. 2, 1908.)—Having previously given an account of the relation between the illumination and the conductivity of selenium [Abstract No. 671 (1908)], the author has extended the investigation to the connection between the current density of the Röntgen rays and the conductivity of a selenium cell. With the Röntgen-ray tube a rotary motor mercury interrupter was used. The tube was placed at various distances from the cell, and the changes of the resistance observed by means of a Kirchhoff-Wheatstone bridge. It was found that the Röntgen radiation followed the same law of the distance as in the case of light, and varied inversely as the square of the distance. The formula $i = K(K - a)b$, which expresses the relation between the illumination i and the conductivity of the selenium cell K, is identical with the formula for the Röntgen radiation. Thus by means of selenium the intensities of two Röntgen tubes may be compared. By this means also a comparison may be made between a light-radiation and a Röntgen radiation. [Compare Luraschi, Abstract No. 855 1908).] J. J. S.

283. *Influence of Hydrostatic Pressure on the Thermoelectric Properties of Metals.* **E. Wagner.** (Ann. d. Physik, 27. 5. pp. 955–1001, Dec. 15, 1908. Physikal. Inst. d. Univ., München, July, 1908.)—When metals are subjected to hydrostatic pressure their thermoelectric behaviour is different from that in the non-compressed condition. The thermo-e.m.f. produced is proportional to the pressure and to the difference of temperature of the junctions. The metal when freed from pressure returns to its original thermoelectric condition. The research described in the paper included 15 metals and 2 alloys, and the results are summed up in the table. The pressure applied extended to 800 kg. per sq. cm., and the temperature interval from 0° to 100° C. The direction of the thermo-e.m.f. produced by pressure in most of the metals (designated by + in the table) indicates a shifting of the compressed metal in the thermoelectric potential series towards antimony.

The value of the thermo-e.m.f. due to a pressure of 1 kg./cm.² with a difference of temperature of 1° at the junctions are given in volts in the first column of the table. The accuracy of the measurements is on the average 1 per cent.

	1.	2.	3.	4.	5.	6.	7.	8.
				Influence of Pressure on the				
	Thermo-E.M.F. under Pressure, $\varepsilon \times 10^{12}$ Volt (58°).	Thermo-E.M.F. towards Copper, Microvolts (60°).	Compressibility $-\frac{dv}{v} \times 10^7$ (18°).	Electron Density $\frac{dN}{N} \times 10^7$ (58°)	Electrical Conductivity $\frac{d(Nl)}{Nl} \times 10^7$ (18°).	Free Path $\frac{dl}{l} \times 10^7$ (about 38°).	Number of Electrons per Gm. $\left(\frac{dv}{v} + \frac{dN}{N}\right)10^7$	$\frac{\frac{dl}{l}}{\frac{dv}{3v}}$
Mg	—8·9	+8·4	29	—1·02	—	—	—80	—
Manganin	—8·5	—0·5	8·1	—0·98	—19	—18	—9·1	+6·7
Sn	—0·95	+8·4	19	—0·11	—	—	—19·1	—
Al	—0·59	+8·6	14	—0·07	+44	+44	—14·0	—9·4
Cu..................	+8·2	0	7·4	+0·87	+21·2	+20·8	—7·0	—8·4
Cu (electrolytic)	+8·2	+0·19	7·4	+0·87	+21·2	+20·8		
Au..................	+4·6	—0·04	6·3	+0·58	—	—	—5·8	—
Pb..................	+5·6	+8·2	24	+0·65	+148	+147	—28·8	—18
Ag..................	+8·7	+0·12	9·6	+1·0	+88	+87	—8·6	—12
Ni	+9·6	+28·2	5·6	+1·10	+15·7	+14·6	—4·5	—8
Fe	+12·5	—9·4	6·0	+1·44	—	—	—4·6	—
Pt	+18·6	+7·9	4·0	+2·14	+19	+16·9	—1·9	—18
Pd..................	+28·7	+11·0	5·6	+2·6	—	—	—8·0	—
Constantan A ...	+81·1	+48·1	6·8	+8·58	+6·4	+8·1	—8·0	—1·5
Constantan B ...	+26·4	+42·0	6·8	+8·04				
Cd..................	+86·8	—1·8	21	+4·17	—	—	—16·8	—
Zn..................	+40	—0·80	17	+4·6	+65	+60	—12·4	—11
Hg	+284	+7·2	89	+26·9	+828	+296	—12	—28
Bi	+707	+80	80	+81·8	—187	—268	+51	+27

In the case of Cd and Zn the value of the thermo-e.m.f. due to the pressure established itself gradually (in the course of some hours), and similarly it disappeared gradually on the removal of the pressure. This phenomenon is probably due to a gradual change in the crystalline condition of the metal under pressure. If the electron theory is applied to the measurements, it follows, first, that through pressure the number of free electrons per c.cm. of most metals increases (column 4), and on the contrary the number in 1 gm. of the metal decreases (column 7) and are in connection with measurements which relate to the pressure influence on the electric conductivity of the metal; second, that this last influence depends in a far higher degree on an increase of the mobility (column 6) of the free electrons than on the change of their density. J. J. S.

284. *Mutual Inductance of Coaxial Solenoids.* **H. Nagaoka.** (Mathematico-Physical Soc., Tôkyô, Proc. 4. 14. pp. 279–284, March, 1908.)—The author still further simplifies the formula he has found for the mutual inductance of two coaxial and concentric solenoids by means of known properties of *q* series [see Abstract No. 272 (1908)]. He recalculates the numerical example considered by Roiti and L. Cohen [Abstract No. 1401 (1907)]. He gives all the arithmetic, and his final result is in exact agreement with that obtained by Roiti and differs by a practically negligible amount from that given by Cohen, who used Legendre's tables. He points out also that Viriamu Jones's and A. Russell's formulæ may be expressed conveniently in *q* series in certain cases. A. R.

285. *Distributed Capacity of Resistance Coils.* **S. L. Brown.** (Phys. Rev. 27. pp. 511–514, Dec., 1908.)—Taylor and Williams have recently attempted to construct a resistance coil which would be free from inductance and capacity [see Abstract No. 1477 (1908)]. At the time the author was working on a similar problem, and the results which he obtained indicated that there was an excess of capacity over inductance in such a coil. Measurements on a rectangular coil similar to that used by Taylor and Williams showed a considerable excess of capacity over inductance. When the coil was in air, 420 mfd. of capacity were added in parallel with the standard to obtain a balance, while when the coil was immersed in petroleum 685 mfd. were similarly required. The capacities which were added to obtain a balance between the coil and the standard were made of rectangular sheets of tin-foil, separated by a plate of glass. The capacities could thus be determined approximately by calculation. From the dimensions of the coil &c., the excess of capacity over inductance was calculated to be 855 mfd. in the first case and about 800 mfd. in the second. F. E. S.

286. *Thermoelectric Forces in Electrolytes.* **E. Podszus.** (Ann. d. Physik, 27. 4. pp. 859–880, Nov. 26, 1908. Extract from Dissertation, Berlin.)—By means of a suitable apparatus the author has measured the thermoelectric forces of different electrolytes and shown that they are proportional to the difference in temperature but almost independent of the concentration. For electrolytes with the same anion the thermoelectric forces range themselves in a series which corresponds approximately to the positions of the kathions in the periodic system. In general, the current flows from the cooler to the warmer junction when the circuit of the combination is closed. An attempt was made to determine the constants *k* and *k'* of Nernst's theory, but the results were unsatisfactory. T. S. P.

287. *Silver Voltameter and Weston Normal Cell.* **W. Jaeger and H. v. Steinwehr.** (Zeitschr. Instrumentenk. 28. pp. 327–340, Nov., and pp. 353–368, Dec., 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—

Describes an investigation of the silver voltameter and a determination of the e.m.f. of the Weston normal cell in international measure. The cells used were of two kinds; the newer ones contained mercurous sulphate prepared by a method suggested by Steinwehr [see Abstract No. 1981 (1905)], but the older cells were not made in accordance with modern specifications. The mean e.m.f. of the latter cells was determined to be 1·01844 int. volts at 20° C., and the mean e.m.f. of the newer cells was found to be 1·01884 int. volts at the same temperature. The value found by Ayrton, Mather, and Smith for the new Weston cell is 1·01848 int. volts at 20° C. [see Abstract No. 469 (1908)]. Particulars of 5 old cells are given and the max. difference in e.m.f. was about 11 parts in 100,000. The newer cells referred to are 8 in number and the max. difference in e.m.f. was 25 parts in 100,000. To determine the e.m.f. 28 observations, extending from June, 1906, to March, 1908, were made. The first 14 of these observations were made using the porous pot form (Richards' form) of voltameter, and the mean value found for the e.m.f. was 1·01848$_5$ volts. The last 14 observations were made using the usual form of voltameter, and gave a mean of 1·01888$_5$ volts. If the difference is due to the form of voltameter the deposit was heavier (comparatively) in the porous pot form. As a check, 6 experiments were made with the two forms in series, and the deposits in the porous pot form were, respectively, 5, 7, 1, 6, –11, and –8 parts in 100,000 heavier than in the usual form. The general conclusion is that there is no certain difference between the forms, and agrees with the conclusions of Smith, Mather, and Lowry [see Abstract No. 868 (1908)] but is contrary to the results arrived at by many of the older observers. Deposits were also made from solutions in contact with atmospheres of air, nitrogen, and hydrogen. There was no certain difference in the deposited masses of silver when air and nitrogen were used, but with hydrogen heavier deposits were obtained. F. E. S.

288. *"Speaking" Dynamos and Transformers.* **W. Peukert.** (Elektrotechn. Zeitschr. 30. pp. 51–52, Jan. 21, 1909; Elect. Engin. 43. p. 272, Feb. 19, 1909.)—Some experiments are described which show how the arrangement of the "speaking" condenser can be applied to a dynamo or transformer, the microphone current being superposed on the ordinary magnetising current. The sound production is very loud. The arrangement can also be used to reproduce audibly the pulsations of voltage of a dynamo. L. H. W.

289. *Adjustment of the Quadrant Electrometer.* **H. Scholl.** (Phys. Zeitschr. 9. pp. 915–919, Dec. 15, 1908.)—The deviation from the linear relation between sensitiveness and needle potential has been variously explained by Walker, Cohnstädt, and Dolezalek. It is ascribed by the author to the change of capacity caused by want of planeness of the surfaces of the needle and quadrants. As irregularities of these surfaces are unavoidable, a perfectly straight capacity curve cannot be obtained; but by adjustment, chiefly by means of the levelling screws, the relative positions of needle and quadrants may be made such that the capacity curve has a horizontal tangent for the zero position of the needle. A half-hour's systematic adjustment was necessary to attain this condition in the case of a quadrant electrometer to which the principles of adjustment mentioned had not been previously applied. A needle is sketched and described which gives good results. The blade is of platinised mica with a relatively heavy suspension to prevent lateral motion of the axis. G. E. A.

290. *Rotating Commutator for Rectifying an Oscillatory Discharge.* **N. Bulgakov.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. No. 6. pp. 295–302 [Physical Part], 1908.)—It has been observed by various investigators that, with an oscillating discharge, the current in the discharge circuit changes its direction if the resistance of the circuit is less than $2\sqrt{(L/C)}$, where L is the self-induction and C the capacity of the discharging condenser. The author has designed a rotating commutator for rectifying the oscillatory discharge, so that the currents in both directions may be observed directly by means of a galvanometer. The device consists of three rotating drums or cams, one for charging the condenser, another, possessing a high coefficient of self-induction, for discharging the condenser through the circuit, and the third for closing for some time a lateral circuit containing a galvanometer through which the current flows in one direction. So that, if the form and speed of the commutator are suitably adjusted, there passes through the galvanometer only the current corresponding with one odd or one even half-period. For sketches and details of the arrangement the original must be consulted. T. H. P.

291. *Shielded Galvanometer.* **E. F. Nichols** and **S. R. Williams.** (Phys. Rev. 27. pp. 250–257, Oct., 1908.)—Constructional details are given as to the needle, the suspension and the triple shield of silica [silicon ?] steel. The galvanometer described, giving 1 mm. deflection at 1 m. for 4×10^{-10} volts and having a period of (double) swing of 6 sec., kept to a zero within 2 scale divisions during heaviest traffic with electric cars passing within 25 m. of the instrument. L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

292. *Effect of Load and Vibrations upon Magnetism in Nickel.* **J. Russell.** (Roy. Soc. Edinburgh, Proc. 29. pp. 38–56, 1908.)—The irreversible and reversible effects of load with and without permanently-acting mechanical vibrations were investigated (1) in fields increasing from zero (A1 conditions), (2) in cyclic fields (A2), and (3) in zero field with what is called cyclic residual magnetisation (A3). When loading and unloading is superposed upon magnetisation (A conditions) the magnetic changes following upon load changes are compounded of (*a*) the irreversible vibrational effects due to molecular instability, and (*b*) the reversible effects of loading and unloading. In general the initial effects (*a*) are most marked on the first superposition of load. They decrease and finally vanish when "ons" and "offs" of load are sufficiently often repeated, leaving only the final reversible effects (*b*). Both effects are clearly distinguishable from each other and traceable in regular sequence at all stages of increasing field (A1), cyclic field (A2), or cyclic residual magnetisation (A3). Permanently acting vibrations lessen or eliminate the irreversible effects (*a*), but increase the reversible effects (*b*). In the experiments described annealed nickel was used. From the curves obtained representing the first "on" of various loads under conditions A1, it appears that effect (*a*) increases the induction, while effect (*b*) decreases the induction to a greater extent the greater the load. At low inductions the former predominates. The irreversible changes (*a*) due to *repeated* loading and unloading under conditions A1 accentuate the induction-increase due to the first superposition of load, especially in low fields. Under conditions A2 the first "on" or "off" of load increases the induction at cyclic extremes, decreases the residual magnetisation, and lessens those differences to which hysteresis has given rise. Similar effects occur with repeated loading and unloading under A2 conditions. The vibrational neutral points in the first and third quadrants are where the changes due to loading and unloading (induction decrease and increase respectively) assume their final reversible values from the first, the (*a*) effect being zero. These neutral points are thrust towards or from the cyclic extremes as the amplitudes are greater or less. Permanently acting vibrations eliminate the irreversible effects (*a*) to a greater extent under conditions A1 than under conditions A2 where the cyclic fields are steepest. Under all the above conditions the irreversible effects are subject to the laws which govern the superposition of mechanical vibrations. They depend in cases A2 and A3 upon the tendency of differerent molecular groups of unequal stability to rotate in opposed directions, consequent upon the nickel wire having been previously subjected to at least one reversal of field change. The reversible effects (*b*) are such that under the A1 conditions loading and unloading sufficiently often repeated decrease and increase the induction by equal amounts respectively. The curves representing the final reversible effects of "ons" and "offs" of load when reversals of field increasing from zero are superposed (B1 conditions) when there are no vibrations exhibit magnetic, but not load hysteresis; those under A1 conditions exhibit load hysteresis, but eliminate to a large extent magnetic hysteresis; while the curves with permanently acting vibrations eliminate both magnetic and load hysteresis. The load curve always falls below the corresponding curve without load. The reversible effects (*b*) under conditions A2 and A3 are more complex, and show that in cyclic fields there are well-marked Villari reversals in nickel. These Villari reversals depend upon the molecular condition impressed upon the nickel by the cyclic field process, independent of the presence of the field itself. It is possible that after the irreversible vibrational effects have secured permanent stability under the conditions of the various molecular groups, those positions where the nice balancing of opposing changes due to loading and unloading occurs constitute cyclic Villari critical points in nickel. J. J. S.

293. *Action of the Magnetic Field on Metallic Deposits obtained by Kathodic Projection.* **G. Accolla.** (Accad. Lincei, Atti, 17. pp. 643–649, Dec. 6, 1908.)—Films of Bi, Cu, and Ni have been produced by kathodic projection in magnetic fields of varying intensities. It is concluded that Bi easily undergoes kathodic disgregation, which is greater the more complete the vacuum, and that the magnetic field has no appreciable effect upon its existence. Copper undergoes pulverisation less readily than Bi, and Ni still less so. Nickel is more readily deposited at lower pressures, and the deposits are more distinct when produced in a magnetic field. The form of the deposits confirms Maurain's theory that the metallic particles are electrically charged and arrange themselves along the lines of force of the field [see Abstract No. 890 (1906)]. W. H. Sı.

294. *Magnetic Properties of Elements.* **P. Pascal.** (Comptes Rendus, 147. pp. 1290–1291, Dec. 14, 1908.)—The law is enunciated that atomic susceptibility is an exponential function of atomic weight for dia-magnetic elements of the same valency and analogous chemical properties. "Atomic susceptibility" (χ_a) is defined as the product of specific susceptibility (χ_s) and atomic weight (*a*). The form of the relation approximately followed is $\log \chi_a = \alpha + \beta a$. α and β are constants, dependent on valency;

a varies slightly, β increases regularly with valency. The following figures are obtained from the data of Curie, Kœnigsberger, and St. Meyer, and the author's determinations of χ, for Cl ($-5{\cdot}90 \times 10^{-7}$), Br ($-3{\cdot}99 \times 10^{-7}$), and P ($-3{\cdot}84 \times 10^{-7}$):—

For Cl, Br, I, value of $\log(-10^7 \cdot \chi_a) = 2{\cdot}2 + 0{\cdot}0087a$—

	Cl	Br	I
Calculated	2·3311	2·5040	2·6674
Observed	2·3201	2·5038	2·6667

For S, Se, Te, $\log(-10^7 \chi_a) = 2{\cdot}07 + 0{\cdot}00418a$—

	S	Se	Te
Calculated	2·2040	2·4010	2·5925
Observed	2·2006	2·3984	2·5994

For P, As, Sb, Bi, $\log(-10^7 \chi_a) = 2{\cdot}26\ a\ 0{\cdot}00564a$—

	P	As	Sb	Bi (at 20°)
Calculated	2·4348	2·683	2·9379	3·4361
Observed	2·4358	2·683	2·8895	3·4263

Similar relations hold for the alkaline and alkaline earth metals. [See also Abstract No. 2022 (1908), and Journ. de Physique, 7. pp. 921–930, Dec., 1908, which contains an amplified account of the experiments, excluding what is dealt with in the present Abstract.] F. R.

295. *Earth-current Registration at Batavia.* **W. van Bemmelen.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 242–248, Nov. 26, 1908.)—In previous papers [Abstracts Nos. 854, 1283 (1908)] the author has examined the question of the abnormal intensity of the earth-current between Batavia and Anjer. New measurements have been made on wires laid in various orientations. These were compared with the variations of the horizontal magnetic component directed perpendicularly on the straight line connecting the two stations. The records indicate that each oscillation of the earth-current corresponded with one of the magnetic components; the oscillations of the earth-currents precede those of H.F., with a certain difference of phase; their amplitudes increase compared with those of the force, while the duration decreases. Examination of the various geological formations of the earth's crust encountered on the path of the various lines utilised appears to indicate a connection between potential gradient and formation, such that the gradient is least in alluvium, greater in quaternary, and greatest of all in volcanic strata. C. P. B.

296. *Properties of a Hexagonal Group of very small Magnets.* **L. de la Rive** and **C. E. Guye.** (Comptes Rendus, 148. pp. 161–164, Jan. 18, 1909.)—Describes the phenomena observed with, and the characteristic property of a hexagonal arrangement of little compass-needles. The needles were 18 mm. long and pivoted in small cylindrical boxes which were arranged regularly at the vertices of equilateral triangles, forming a hexagonal network. The surface covered by the magnets was a hexagon whose radius was 20 cm., and included 199 magnets. The characteristic property of the hexagonal network is the orientation of the magnets exclusively along one of the three

hexagonal directions, even under the influence of a fairly large exterior field. Sometimes the magnets are all in one direction, at others the directions are different at different parts of the network. A fact worthy of notice is the following: If the whole arrangement is turned about its centre through an angle a little less than 30°, the orientation persists. On continuing the rotation till the angle turned through is slightly greater than 30°, a sudden change takes place in the orientation of the magnets, which set in the next hexagonal direction, so that the angle between the magnets and the direction of the field is less than 30°. This is of interest in view of the sudden changes, though more complex than in this case, observed by Weiss in his researches on the magnetic properties of pyrrhotine. A. W.

REFERENCES.

297. *Phenomena due to Collisions between Electrons, Ions, Atoms, and Molecules.* **A. Righi.** (Journ. de Physique, 7. pp. 589–617, Aug., 1908. Paper read before the Soc. franç. de Physique.)—Discusses the subject of magnetic rays [see Abstract No. 952 (1908)].

298. *Aurora Borealis and Kathode Rays.* **P. Villard.** (Journ. de Physique, 7. pp. 429–453, June, 1908. Paper read before the Soc. franç. de Physique.)—An amplified account of work already dealt with [see Abstracts Nos. 1429, 1608 (1906)].

299. *"Pinch-effect" in Unidirectional Electric Sparks.* **A. H. Patterson.** (Science, 29. pp. 26–27, Jan. 1, 1909.)—Attributes the effects observed by Nipher [Abstract No. 271 (1909)], as regards unidirectional sparks, to the "pinch-effect" in gaseous discharge. L. H. W.

300. *Scattering of Electromagnetic Waves by a Small Elliptic Cylinder.* **K. Aichi.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 14. pp. 266–278, March, 1908.) —The scattering of electromagnetic waves of very large wave-lengths by a small elliptic cylinder is discussed by means of elliptic-cylindrical functions. The paper is purely mathematical and cannot be abstracted. T. P. B.

301. *Change of Resistance of Pure Metals at very Low Temperatures and the Influence exerted on it by small amounts of Admixtures.* II. **H. Kamerlingh Onnes** and **J. Clay.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 345–346, Dec. 23, 1908. Communication No. 107*c* from the Phys. Lab., Leiden.)—Supplementary notes to communication 99*c* [Abstract No. 850 (1908)]. W. C. S. P.

302. *Temperature Formula of Weston Cell.* **F. A. Wolff.** (Bureau of Standards, Bull. 5. pp. 309–337, Nov., 1908.)—This is the Bureau of Standards reprint of a paper already abstracted [see Abstract No. 1680 (1908)] together with a section dealing with the behaviour of the Weston cell with rapid temperature changes. In most cases the cells practically attained their normal values within 5 hours after an abrupt change of temperature of over 20° C. F. E. S.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

303. *Melting in the Induction Furnace.* **F. A. J. FitzGerald.** (Electrochem. Ind., N.Y. 7. pp. 10–11, Jan., 1909.)—As the thermal efficiency of an electric furnace for melting metal is greater, other things being equal, the more rapidly the operation is conducted, there seems to be some question as to the efficiency of the induction furnace in view of the limitation of the power which can be supplied to it, by the "pinch-effect," and of the large surface of the annular crucible by which heat can be removed by conduction and radiation. Particulars of a trial of a 125-kw. 2,000-lb. experimental furnace are given which leads to the conclusion that the induction type of furnace is more efficient than these reasons might indicate. Starting with a molten steel bath of 850 lbs. and 580 volts on the primary, 68 minutes were required to melt the remainder of the charge completely; this consisted of 450 lbs. of washed metal and 450 lbs. of muck bar. The mean kw. whilst running was 116, max. 125. The "pinch-effect" was not obtained, so that the limitations of the rate of heating are not yet determined. Curves of the kw. and power factor are given. F. R.

304. *Aluminium Carbide.* **P. Askenasy, W. Jarkowsky, and A. Waniczek.** (Zeitschr. Elektrochem. 14. pp. 811–813, Dec. 11, 1908. Inst. f. physikal. Chemie u. Elektrochemie d. techn. Hochschule, Karlsruhe.)—Aluminium carbide, Al_4C_3, was obtained by heating mixed calcined clay and charcoal in the electric furnace. Upon heating the carbide at a temperature slightly above the melting-point of Al, beads of Al formed upon it, in air or an atmosphere of CO_2 or H. It is probable that the carbide has a critical temperature, slightly higher than the melting-point of Al, at which it forms in heating or dissociates in cooling. The yield of carbide was poor when cooling was slow and high with rapid cooling. F. R.

305. *New Thermit Reactions.* **H. Goldschmidt.** (Zeitschr. Elektrochem. 14. pp. 558–564, Aug. 28, 1908. Paper read before the 15. Hauptversamml. d. Deutsch. Bunsen-Gesell. Electrochem. Ind., N.Y. 6. pp. 360–362, Sept., 1908.)—Discusses new thermit reactions in which, instead of Al, other active elements are used. Silicon does not reduce Cr_2O_3, Mn_2O_3, or Mn_3O_4; MnO_2 is reducible, but a certain amount of Si remains in the metal. The copper oxide reaction goes slowly, and the slag contains small globules of copper silicide containing 10 per cent. Si. Calcium reduces in a similar manner metallic oxides, sulphides, &c. The Ca-Si iron reduction is very similar to the Al reduction, but the slag is more easily fusible, and does not solidify so rapidly as the Al_2O_3 slag. The advantages of using mixtures for these reductions are pointed out; a good thermit mixture is made by Ca and Si in the proportion 2 : 1; this mixture gives 720 kg.-cals., whilst the usual thermit gives about 820 kg.-cals. Sixty parts Mg and 40 parts Si also forms a good mixture. With a mixture of 40 per cent. Ca thermit and 60 per cent. Al thermit in which Ca : Al : : 53 : 47, 850 kg.-cals. are developed, and the slag produced is particularly fluid, this slag corresponding to $2CaO . 2Al_2O_3$. A mixture of Al-Ca-Si is also used, the best proportion being 20 Al, 47 Ca, and 33 Si, the result of the reaction being a slag Al_2O_3, $3CaO$, $3SiO_2$, which has a melting-point of 1,345° C. C. O. B.

306. *Constitution of Copper Mattes.* **C. H. Fulton and I. E. Goodner.** (Amer. Inst. Mining Engin., Bull. 24. pp. 959–995, Nov., 1908. Contribution from the Metallurg. Lab., S. Dakota School of Mines.)—Contains a review and discussion of the various binary systems of the metallic sulphides, and the binary systems of various metals and their respective sulphides entering into the constitution of mattes, also a discussion of the physical and chemical properties of these sulphides. Gives a description of the results obtained from the chemical and metallographic examinations of samples of copper-iron and copper-lead-iron matte obtained from various plants, and also a discussion of the constitution of mattes based on the above data. All copper-iron mattes were found to be conglomerates; there is a distinct eutectic present, often very well developed, especially in slowly cooled mattes of low copper contents. When the matte contains 60 per cent. Cu, no eutectic is visible as this represents the saturated solid solution of FeS-Fe in Cu_2S-Cu. Many specimens contained cavities, cracks, and inclusions like gas-bubbles. Metallic Cu is of common occurrence, and may be found in mattes of almost any copper content. It most generally occurs as thin, flat sheets and wires, which, in the microscopic section, appear as long thin seams. These invariably occur in the solid solution mentioned above. As to which constituents of a matte act as solvents for the precious metals, it is shown that cuprous sulphide and silver sulphide form an unbroken series of mixed crystals, and that when cuprous sulphide is present Ag is in solution in this substance as sulphide. Metallic Cu also acts as a powerful solvent for Ag and Au. Lead sulphide has a considerable solvent action on silver sulphide, but probably only a limited one on Au. Zinc sulphide has very little solvent action on silver sulphide and probably little on Au. Metallic iron, which is often present, has a powerful solvent action on Au, but a very limited one on Ag. Ferrous sulphide has practically no solvent action on silver sulphide or on Au. Arsenic and Sb are present usually in very small amounts, and their presence has practically no significance as a solvent for the precious metals. C. O. B.

307. *Hardness of Solid Solutions and Compounds.* **N. S. Kurnakow and S. F. Żemczużny.** (Zeitschr. Anorg. Chem. 60. 1. pp. 1–87, Oct. 1, 1908.)—A review of the literature of the subject leads to the following generalisations for metals: The hardness of a series of solid solutions of two metals is a smooth curve having a maximum, which occurs at the same concentration as the minimum of electrical conductivity. An alteration in the composition of the solid phase—*i.e.*, the occurrence of a compound in a series of binary alloys—is accompanied by a sudden change in direction of the hardness curve. If a mechanical mixture, but neither solid solutions nor compounds, be formed between the two metals, the curve of hardness is a straight line. The hardness-curve of binary systems in which complex equilibrium diagrams occur will be combinations of these curves. Experimental results are given in which the hardnesses of isomorphous mixtures of *p*-dichlorbenzene with *p*-dibrombenzene and of AgCl with AgBr were determined by recording the pressure required to cause them to flow through a die. The curves are in both cases of the type corresponding to an uninterrupted series of solid solutions. In the former case the maximum occurs with 71·36 mols. per cent. of $C_6H_4Br_2$, and in the latter with 50 mols. per cent. of AgBr. Published data and the authors' work further show that the hardness of a binary compound of two metals or a metal and a metalloid increases in general with the hardness of its components. Thus we have—

the numbers being on Mohs' scale—Sn 1·8, Cu 3·0, Mg 2·0, Mg_2Sn 3·5, Mg_2Cu 4·5; Cd 2·0, Ni 4, Co 4, Sb 3, CdSb 3·5, CoSb 5·5, NiSb 5–5·5. Phosphorus and arsenic increase the hardness of metals greatly. The simultaneous variation of contraction of volume and heat of formation of compounds is well known. The hardness also increases with these properties. This is well shown in the case of oxides of the type R_2O_3. The hardness of the oxide is relatively very great compared with that of the respective metal when polymerisation occurs; *e.g.*, we have the hardness of Be 8, Al 2·9, Mg 2, Sn 1·8, and of BeO 8, Al_2O_3 9, MgO 6, SnO_2 6–7. The great contraction upon formation of FeS_2 from FeS, and its hardness (6·0–6·5 as compared with FeS 3·5–4·5) are in favour of the theory that it is a polymerised compound.

F. R.

308. *"Tin Pest" on Old Coins.* **E. Cohen.** (Zeitschr. Phys. Chem. 63. 5. pp. 625–634, Aug. 21, 1908.)—The gradual crumbling of old tin coins, organ-pipes, and vessels [see Abstract No. 2807 (1904)], which is frequently observed, is ascribed by the author to the fact that the coins, &c., have been during long periods below the transformation-point (18°), and so have become converted in part into the brittle grey variety of tin. Such coins should therefore be preserved at or above 18°, but although warming to this temperature will allow the change to the tough form to occur, yet if crumbling has once commenced the cohesion cannot be restored without fusion. Dilatometric measurements are given, showing that the transformation temperature is 18° very closely. Analyses of grey and white tin from the same original ingot show very little difference.

F. R.

309. *Alloys of Co with Sn, Sb, Pb, Bi, Tl, Zn, Cd, Cr, and Si.* **K. Lewkonja.** (Zeitschr. Anorg. Chem. 59. 3. pp. 293–345, Aug. 28, 1908. Metallographic Communication from the Inst. f. physikal. Chem. d. Univ., Göttingen.)—Describes an investigation of these alloys by the method of thermal analysis, the results being substantiated by microscopic examination. In addition, the magnetic properties of the alloys were investigated. Co and Sn are completely miscible in the liquid state. Co retains about 3·5 per cent. Sn in solid solution, and, in addition, gives rise to three compounds: Co_2Sn melting at 1,151° C.; CoSn, which undergoes a polymorphic change at 526° C., and melts with decomposition into Co_2Sn + liquid, at 948° C. Only the alloys containing more than 50 per cent. Co (*i.e.*, those containing solid solution of Sn in Co) are magnetic, the permeability increasing with the Co content. The alloys lose their magnetic properties at temperatures approaching 1,000° C. Co and Sb are completely miscible in the liquid state. Co retains about 12·5 per cent. Sb in solid solution, and gives rise to the compounds CoSb and $CoSb_2$ melting at 1,191° C., and 897·5° C. respectively, the latter decomposing into CoSb + liquid. Only the alloys containing up to 67 per cent. Sb are magnetic, the permeability increasing with the Co content. The alloys undergo a magnetic reversal at 925° C. Co and Sb, Co and Bi, and Co and Tl are only very partially miscible in the liquid state, while in the solid they form neither solid solutions nor compounds. The Co-Zn alloys were only investigated up to 18·5 per cent. Co. 0·5 per cent. Co lowers the melting-point of Zn to 418° C., after which the curve rises to the melting-point of a compound, probably $CoZn_4$. Between 0·5 and 18·5 per cent. Co a solid solution separates, containing 18·4 per cent. Co when saturated. None of the alloys are magnetic. Co and Cr are completely miscible in the liquid state, and form a continuous series of solid solutions. The solidification curve shows a minimum at 1,320° C., the alloy containing 47 per cent. Cr. The alloys containing from 0 to 25 per cent. Cr are magnetic, the 15 per cent. alloy having the highest permeability. The temperature of loss of magnetic properties falls rapidly with increase of Cr. Co and Si are miscible in all proportions in the liquid state, and give rise to a very complicated diagram. Co retains 7·5 per cent. Si, and Si 9 per cent. Co in solid solution. Five compounds solidify from the liquid: Co_2Si which melts at 1,327° C., CoSi at 1,393° C., $CoSi_2$ at 1,277° C., and $CoSi_3$ at 1,307° C. In the solid state, Co_3Si_2 is formed by a reaction between Co_2Si and CoSi. The temperature of formation of Co_3Si_2 is lowered by the presence of excess Co_2Si. Only the alloys containing 0 — 19·5 per cent. Si are magnetic. The paper is illustrated by eleven diagrams and five plates of micrographs, and concludes with a table showing the relations of Co, Ni, and Fe to each other and the periodic system.

F. C. A. H. L.

310. *Melting and Vaporisation Temperatures of Sulphides.* **W. Biltz.** (Zeitschr. Anorg. Chem. 59. 3. pp. 273–284, Aug. 28, 1908. Chem. Laborat. d. Bergakademie, Clausthal.)—The melting-point of lead sulphide is 1,112° ± 2°. The sublimation of zinc sulphide occurs at 1,182°, of cadmium sulphide at 980° ± 20°, and of mercuric sulphide at 446° ± 10°. It is pointed out that the ratios of these sublimation temperatures to the boiling-points of the respective metals are respectively 1·29, 1·26, 1·25, or with absolute temperatures 1·22, 1·19, 1·14. (The boiling-points used are Zn 920°, Cd 779°, Hg 357°.) The melting-point of ferrous sulphide is 1,197° ± 2°, of nickel sulphide 797° ± 2°, and of cobalt sulphide over 1,100°. The melting-point of tin sulphide was given as from 950° to 1,000° by Guinchant in 1902, and as 880° by Pélabon [Abstract No. 2162 (1906)]. The author finds that both these values have claims to correctness, for on heating, the sulphide first melts with absorption of heat at 870° and remains molten up to 1,000. Between 1,000° and 1,100° it becomes first pasty and then completely solid. It finally melts again at 1,120°, with further absorption of heat possibly due to the sublimation which commences above 1,100°. As to whether a new sulphide is formed at the higher temperature or the changes are analogous to those which occur in sulphur upon heating is as yet undecided. The sulphide, however, appeared to remain unchanged when quenched from temperatures of 1,000–1,200°.

F. R.

311. *Cobalt-Antimony Alloys.* **F. Ducelliez.** (Comptes Rendus, 147. pp. 1048–1050, Nov. 30, 1908.)—The action of antimony trichloride with powdered cobalt at from 700° to 1,200° yields the non-magnetic compound CoSb, of density 8·12, melting-point about 1,200°. At temperatures above 1,200° magnetic alloys are obtained containing less Sb than is contained by CoSb. The compound is isolated from these alloys by the action of HCl or H_2SO_4. Alloys with similar properties were also prepared by direct union under hydrogen. Sb is volatilised from CoSb at about 1,450°. Alloys richer in Sb than the compound CoSb readily lose Sb on heating. $CoSb_2$ is separated from Sb-rich alloys by means of HCl or KOH. The density of this compound is 7·76; it melts and decomposes under hydrogen at 700°.

F. R.

312. *System Copper-Arsenic: Temperature-concentration Diagram and Electrical Resistance.* **K. Friedrich.** (Metallurgie, 5. pp. 529–535, Sept. 22, 1908. Communication from the Metallograph. u. Metallurg. Laborat. d. Kgl.

Bergakademie, Freiburg.)—A redetermination of the temperature concentration diagram of the system up to about 45 per cent. As confirms the existence of the compound Cu_3As_2, the probability of the existence of Cu_5As, and the non-existence of the compound Cu_2As mentioned by Hiorns [Abstract No. 2227 (1904)]. At about 700°C., Cu may contain up to about 4 per cent. As in solid solution. The high-As alloys undergo change very slowly at atmospheric temperature, probably through volatilisation of As from the As-rich constituent. Electrical resistance measurements of alloys containing up to 11·8 per cent. As show that there is a sharp kink in the curve at about 4 per cent. As. Each addition of As causes a great increase in the resistance of copper. F. R.

313. *Uranium Silicide* (*$UrSi_2$*). **E. Defacqz.** (Comptes Rendus, 147. pp. 1050–1052, Nov. 30, 1908.)—As in the case of the silicides of Mo and W [see Abstracts Nos. 1100 and 1418 (1907)], the author prepares the silicide of uranium, $UrSi_2$, by heating in the electric furnace, or by the aluminothermic method, a mixture of powdered Al, sulphur, calcined silica, and uranium oxide. The density of $UrSi_2$ at 0° is 8. It is soluble in HF, but not in the ordinary acids, nor in aqua regia. Oxidising agents have only a very slow action upon it. F. R.

314. *Effect of Titanium on Cast Iron.* **B. Feise.** (Stahl u. Eisen, 28. pp. 697–699, May 13, 1908.)—The Ti used in these experiments was reduced from rutile by the Al reduction method. The Ti was added to cast iron in three different quantities, 0·25, 0·5, and 1·0 per cent, and test-pieces, together with checks from the cast iron, were cast vertically, and found to be homogeneous. Test-pieces 600 mm. long and 8·14 cm.^{2} in cross-section were used for deflection tests, the greatest weight used being 8,000 kg. corresponding to 955 kg. per cm.^{2} cross-section; a table is given showing the deflections obtained per cm. of length for the different weights used. The effect of the Ti is to diminish the deflection of the test-pieces, especially in the 0·25 per cent. Ti specimen; the effect is not so marked in the 0·5 or 1 per cent. Ti specimens, the latter giving tests very similar to the cast iron. C. O. B.

315. *Effect of Mechanical Treatment on Physical Qualities of Steel.* **J. E. York.** (Iron and Steel Inst., Journ. 76. pp. 167–178, 1908. Engineering, 85. pp. 784–785, May 29, 1908.)—Points out the great difference in speed of rolling ingots now, as compared to twenty years ago, and the effect of this on the properties of the finished material. Considers the correct heating of ingots for rolling, and states that the finishing temperature should be as low as possible to get good results, and that the initial temperature should not be above 950°; if, under these conditions, the ingot cannot be rolled to four rail-lengths in one operation, the initial size should be reduced before rolling. Steel ingots suffer from three defects, viz., pipes, segregation, and blow-holes, and it is pointed out that ordinary mills stretch the metal by rolling, and therefore lengthen both the pipe and ingot simultaneously. The author describes his method for solidifying ingots by transverse rolling. It is further pointed out that the idea that the high speed given to rolls in modern mills causes inferior rails is a mistaken one, and that, provided the metal is comparatively solid and not overheated, and the rolling action is on correct lines, then high rolling-speeds will cause no deterioration in the physical properties of the finished product. C. O. B.

316. *Experimental Research on Solidification and Fusion of a Technical Phosphoric Pig-iron.* **N. Gutowsky.** (Metallurgie, 5. pp. 468–470, Aug. 22, 1908. Communication from the Laborat. f. Kleingefüge d. Kgl. Bergakademie, Berlin.)—The cooling curve of a phosphoric pig-iron, containing 1·82 per cent. P and 2·05 per cent. Si, shows, in addition to the eutectic and pearlite points, two fairly definite critical points: x_2 at 1,095° C., and x_1 at 944° C. x_1 is associated with the solidification of the phosphide-rich liquid, while x_2 is due to an intense graphite formation brought about by the presence of Si. Microscopic examination of specimens quenched from various temperatures shows that in phosphoric iron fusion begins much earlier than in the non-phosphoric irons. This limits its use to low temperatures for technical purposes. The phosphide eutectic fuses at about 980° C., and on heating, slowly dissolves the solid solution forming the ground mass. During slow cooling, the phosphide separates out as a binary eutectic and not as a ternary eutectic, as would be expected from theoretical considerations of a three-component system. This discrepancy is explained by the decomposition of the cementite into ferrite and graphite, which takes place during the solidification interval of the solid solution + cementite, and results in the removal of the carbide from the liquid phase. F. C. A. H. L.

317. *Iron-Phosphorus System.* **E. Gercke.** (Metallurgie, 5. pp. 604–609, Oct. 22, 1908. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—Thermal and micrographic data obtained from alloys containing up to 10·2 per cent. P, and made from a highly pure Swedish iron, lead to the following conclusions: The eutectic $Fe—Fe_3P$ is found in all the alloys between 1·7 and 10·2 per cent. P. Its solidification temperature is 980° C., but this may be lowered to 880° by supercooling. P is held in solid solution in Fe up to 1·7 per cent. Structural changes occur in the solid solution at temperatures below the point of solidification. Up to about 8·5 per cent. P the alloys consist of grains of solid solution with more or less network of eutectic; from 8·5 to 10·2 per cent. P the excess solid solution forms crystallites. F. R.

318. *Ternary System: Iron-Carbon-Phosphorus.* **P. Goerens** and **W. Dobbelstein.** (Metallurgie, 5. pp. 561–566, Oct. 8, 1908. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—The triple eutectic is found to solidify at 953° C., and has the percentage composition C 1·96, P 6·89, Fe 91·15. Within the range considered, it is really the ternary system $Fe—Fe_3C—Fe_3P$ which is being dealt with, and the following is a list of the constituents met with in the series: (*a*) dendritic mixed crystals of Fe, Fe_3C, and Fe_3P; (*b*) Fe_3C, or, with sufficient carbon content, graphite; (*c*) Fe_3P; (*d*) binary eutectic: mixed crystals—Fe_3P; (*e*) binary eutectic: mixed crystals—Fe_3C (or graphite); (*f*) binary eutectic: Fe_3C (or graphite)—Fe_3P; (*g*) ternary eutectic: $Fe_3C—Fe_3P$—mixed crystals. Cooling curves and photomicrographs are given. [Compare also Abstract No. 997 (1908).] F. R.

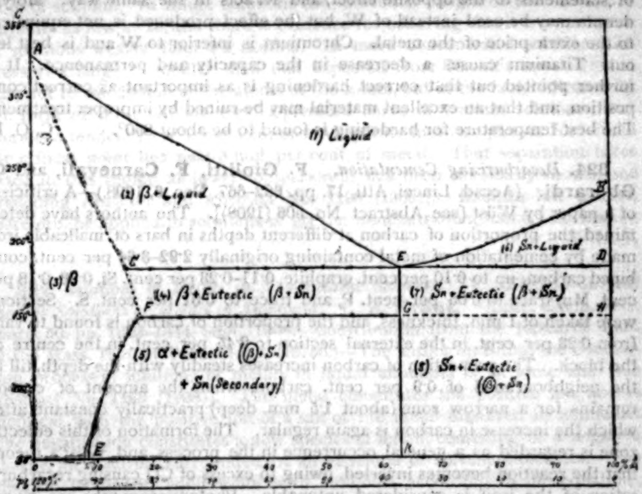
319. *Short Metallographic and Metallurgical Reports.* **K. Friedrich.** (Metallurgie, 5. pp. 593–604, Oct. 22, 1908. Communication from the Metallograph. and Metallurg. Laborat. d. Kgl. Bergakademie, Freiberg.)—No useful results were arrived at in studying the systems Pt—S, Au—Se, Au—S, Au—As, $Zn—Zn_2S$ (or Zn—S) on account of the volatility of the lower boiling component. Photomicrographs taken with ultra-violet light are given

with comparison photomicrographs taken with white light. It is stated that some advantage is obtained by the use of ultra-violet light, but this is so slight as not to be worth the additional trouble and uncertainty involved with such apparatus as is at present available. The loss (largely mechanical) of silver in the distillation of zinc from Zn-Ag alloys at temperatures of from 1,165°–1,892° C. was at most 5·8 per cent. of the original Ag present, viz., from 1 to 0·01 per cent. The results of this work agreed generally with those of Rose (Inst. Mining and Metallurgy, Trans. 14. 1904–1905). Curves show some preliminary results obtained from experiments on the de-silverising of lead, the relation between temperature of distillation and composition being sought. Microscopic and thermal work proved the absence of Ni_2As in the Ni-As alloy, grains of which are contained in cobalt-nickel arsenide. It is possible that Ni_3As_2 is formed during the process of removal of the Co. The Plattner process of de-arsenising cobalt-nickel arsenide is shown to be preferable to that of Fritzsche, as it involves less risk of removing more As than is necessary to leave $Ni_2As + Co_2As$. As to whether the mixture actually consists of these compounds at this stage is left an open question. The dictum commonly accepted in practice, that As has a greater affinity for Ni than for Co, is not strictly correct. The de-arsenising curve is lower for compositions near to NiAs than for compositions near to CoAs. At higher Ni and Co contents the curves cross and the Co curve becomes the higher. F. R.

320. *Cobalt-Tin Alloys.* **S. F. Żemcżużny** and **S. W. Belynsky.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. p. 1468, 1907. Zeitschr. Anorg. Chem. 59. 3. pp. 364–370, Aug. 28, 1908. Translation.)—Contains the results of the thermal examination of this series of alloys, illustrated with photomicrographs. A maximum is obtained with 66 atoms per cent. Co at 1,171°, indicating the compound Co_2Sn. Two eutectics are obtained, one rich in Co and the second rich in Sn. The Co-rich eutectic point occurs with 79·5 atoms per cent. Co at 1,112°. The tin-rich eutectic point occurs at 229° and contains only a small quantity of tin. The compound CoSn also forms at 927° and changes into the β-modification at 515°. The compound CoSn is non-magnetic, and so are all alloys with less than 50 atoms per cent. Co. [See Abstract No. 1421 (1907).] C. O. B.

321. *Thomas Steel Process.* **F. Wüst** and **L. Laval.** (Metallurgie, 5. pp. 431–462, Aug. 8, and pp. 471–489, Aug. 22, 1908. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—Contains a very detailed account of two sets of experiments carried out in a Thomas converter. Gives analyses of materials used and also analyses of metal and slag every minute or two during the blow. From these figures diagrams are constructed showing the progress of oxidation of the metalloids and also the corresponding variation in the composition of the slag. In the metallographic portion the change in structure of the material is illustrated throughout the blow, and the results obtained are used to illustrate the method of elimination of the phosphorus. Material-balances and heat-balances are worked out for the charges, and variations in composition and temperature of the waste gases are also noted. C. O. B.

322. *Eutectics. Lead-Tin Alloys.* **W. Rosenhain** and **P. A. Tucker.** (Roy. Soc., Phil. Trans. Ser. A. 209. pp. 89–122, Nov. 17, 1908. From the National Physical Laboratory. Roy. Soc., Proc. Ser. A. 81. pp. 331–334, Nov. 9, 1908. Abstract.)—On account of their simplicity and ease of manipulation the lead-tin alloys were selected as a convenient starting-point for the systematic study of eutectics, but a redetermination of the eutectic point led to the observation that Roberts-Austen's value (Pb 31, Sn 69 per cent.) was in considerable error, and the value 37 per cent. Pb, 63 per cent. Sn is now given. The temperature-concentration diagram was revised as shown in the Fig. The constitutions of the eight fields are indicated. β is solid solution of tin in lead, saturated at 182·5° C., with rather more than 16 per cent. tin. α is a saturated solution of tin in lead, saturated at a concentration lower than 18 per cent. tin. "Secondary" tin is free finely-divided tin rejected by β on cooling through 149° C., at which temperature α is formed. It is held that grains of pure eutectic are probably true spherulitic crystals possessing a radiating structure, but otherwise similar to holomorphic crystals of pure metals. Prolonged heating of a specimen of eutectic at 175° C. led to segregation of the solid solution β into masses much larger than in the normally cooled eutectic. The compression of a mixture of finely-divided lead and tin gave no apparent diffusion, but the effects of lapse of time and higher temperatures have yet to be determined. Photomicrographs and cooling curves accompany the paper. F. R.



323. *Magnet Steel.* **G. Hannack.** (Stahl u. Eisen, 28. pp. 1237–1240, Aug. 26, 1908.)—Points out that comparatively little is known as to the most suitable chemical composition for steel used for permanent magnets, in which case the various constituents have a very marked effect. Only steels capable of being hardened are suitable, and in this respect a limit is obtained, a certain hardness giving the best capacity. A fine-grained steel is also necessary, and this is obtained by the addition of W. The amount of W to be added is important, it being necessary to add above a certain amount, a case being mentioned in which a few hundredths per cent. of W made the steel worse than a similar steel without W. For carbon magnet-steels the C is fixed at 1·2 per cent., and it is desirable to have the C-limit fixed in the case of W-steels, C and W being by far the most important constituents of magnet steels. Manganese reduces to a certain extent the capacity, a steel higher in Mn than 0·2 to 0·3 per cent. losing its magnetism fairly quickly. Silicon in small quantities is not detrimental, as illustrated by the following analysis of an excellent magnet steel: C 0·60, W 5·87, Mn 0·18, P 0·02, S 0·088, Si 0·25, Cu 0·004. Sulphur and P have no influence on the capacity or permanence of magnet steels. Copper is found to be detrimental in spite of statements to the opposite effect, and Ni acts in the same way. Molybdenum may be used instead of W, but the effect produced is not equivalent to the extra price of the metal. Chromium is inferior to W and is best left out. Titanium causes a decrease in the capacity and permanence. It is further pointed out that correct hardening is as important as correct composition, and that an excellent material may be ruined by improper treatment. The best temperature for hardening is found to be about 850°. C. O. B.

324. *Decarburising Cementation.* **F. Giolitti, F. Carnevali, and G. Gherardi.** (Accad. Lincei, Atti, 17. pp. 662–667, Dec. 6, 1908.)—A criticism of a paper by Wüst [see Abstract No. 506 (1908)]. The authors have determined the proportion of carbon at different depths in bars of malleable iron made by cementation of metal containing originally 2·92–8·64 per cent. combined carbon, up to 0·10 per cent. graphite, 0·11–0·28 per cent. Si, 0·08–0·18 per cent. Mn, trace to 0·05 per cent. P, and trace to 0·01 per cent. S. Sections were taken of 1 mm. thickness, and the proportion of carbon is found to vary from 0·28 per cent. in the external section to 2·45 per cent. in the centre of the block. The proportion of carbon increases steadily with the depth, till in the neighbourhood of 0·9 per cent. carbon, when the amount of carbon remains for a narrow zone (about 1·5 mm. deep) practically constant, after which the increase in carbon is again regular. The formation of this eutectic zone is regarded as a general occurrence in the process, and Wüst's theory that the reaction becomes inverted, owing to excess of CO causing recarburisation of the iron, is considered untenable. Photomicrographs are given, clearly illustrating the results found. W. H. Si.

325. *Solutions of Metals in Non-metallic Solvents.* II. *Formation of Compounds between Metals and Ammonia.* **C. A. Kraus.** (Amer. Chem. Soc., Journ. 80. pp. 653–668, May, 1908. Contribution from the Research Lab. of the Mass. Inst. of Technology, No. 24.)—The author examines the existing experimental data relating to the supposed formation of the compounds $NaNH_3$ and KNH_3 in the light of the phase-rule, and concludes that these compounds do not exist. The same is the case with the supposed compound $LiNH_3$, and, further, the author shows that, in a system containing lithium and a small mol. per cent. of ammonia, a saturated solution of the metal in ammonia is formed—a result which is in agreement with the phase relationships of the system. Calcium forms with ammonia a solid compound $Ca(NH_3)_6$, which exhibits metallic conduction and has optical properties apparently identical with those of its saturated solution in ammonia. The vapour pressures of saturated solutions of lithium and of $Ca(NH_3)_6$ in ammonia are given, as well as the dissociation pressures of the compound itself. The heats of formation of the corresponding solutions and of the compound from metal and gaseous ammonia are calculated to be respectively 8,700, 10,280, and 5,460 cals. per gm.-mol. of ammonia. The constitution of the calcium compound is discussed. [See Abstract No. 1198 (1908).] T. H. P.

326. *Solutions of Metals in Non-metallic Solvents.* III. *Apparent Molecular Weight of Sodium dissolved in Ammonia.* **C. A. Kraus.** (Amer. Chem. Soc., Journ. 30. pp. 1197–1219, Aug., 1908. Contribution from the Research Lab. of the Mass. Inst. of Technology, No. 30.)—By means of special apparatus the author has been able to determine the pressure changes resulting in liquid ammonia on addition of sodium, the accuracy of the measurements being about 1 per cent. for a total pressure-change of 10 mm. The measurements were made at 15° and at dilutions varying from 1 to 18 litres per gm.-atom of sodium. In dilute solutions the molecular weight of the sodium is certainly as low as 23, and there is evidence for believing that it is even lower in solutions weaker than 0·1 normal. In more concentrated solutions the pressure change is smaller than that expected from Raoult's law. This is due, not to association of the atoms of the solute, but to the fact, indicated by the form of the complete vapour-pressure curve of sodium solutions, that there is a tendency for these solutions to separate into two phases for which the critical point lies near 8 mol. per cent. of metal. That separation takes place in this region at lower temperatures has been previously shown [see preceding Abstract and Abstract No. 1193 (1908)]. Raoult's law cannot, therefore, be applied to solutions of greater concentration than 0·1 normal.

T. H. P.

327. *Solutions of Metals in Non-metallic Solvents.* IV. *Electric Current through Solutions of Metals in Ammonia.* **C. A. Kraus.** (Amer. Chem. Soc., Journ. 30. pp. 1323–1344, Sept., 1908. Contribution from the Research Lab. of the Mass. Inst. of Technology, No. 36.)—The author finds that the conduction process in solutions of metals in liquid ammonia is an ionic one [see Abstract No. 1193 (1908)]. The metal constitutes the positive ion, and is identical with the positive ion of a salt of the metal dissolved in ammonia. The negative ion constitutes a new species of anion, consisting of a negative charge, an electron, surrounded by an envelope of solvent molecules. The electron is thus in equilibrium with ammonia according to the equation: $\epsilon^-.(NH_3)_n = \epsilon^- + nNH_3$. At the same time the electron is in equilibrium with the metal kathions and the neutral metal atoms according to the equation $M^+ + \epsilon^- = M\epsilon$, where M^+ signifies the kathion and $M\epsilon$ the neutral atom.

T. H. P.

328. *Supersaturation and Nuclear Condensation of certain Organic Vapours.* **T. H. Laby.** (Roy. Soc., Phil. Trans. Ser. A. 208. pp. 445–474, Aug. 24, 1908. Roy. Soc., Proc. Ser. A. 81. pp. 219–220, Aug. 27, 1908. Abstract.)—The conditions for supersaturation and condensation of certain organic vapours were determined. The apparatus was in principle a Wilson cloud apparatus but several modifications and improvements were introduced to suit the particular work. The least expansion which causes condensation in air initially saturated with an organic vapour and ionised by Röntgen rays was determined. The organic substances employed were six acids—viz., formic to iso-valeric, five esters, chiefly acetates, and iso-amyl alcohol. In the case of acetic acid the expansion required was greater for feeble Röntgen rays than for more intense ones. The supersaturation S, existing at the end of the expansions, was calculated and also for four alcohols and chloroform, from Przibram's experiments. The acids are found, on the whole, to have the largest value of S, and the alcohols the least. The isomers examined have the same value for S, with one exception. In the alcohol group, a regular decrease of S accompanied the addition of a CH_2 group. Values for S were calculated from the present theory of condensation on ionic nuclei and compared with the values of S deduced from the expansion experiments. The agreement is very close in the case of acetic, propionic, *n*-butyric, and iso-butyric acids and methyl alcohol. The expansion and supersaturation necessary for condensation on natural nuclei were determined for the same dust-free vapours. In the case of formic, acetic, and butyric acids the expansion required to catch the natural nuclei was greater than that required for the ionic nuclei produced by Röntgen rays. Ethyl acetate, methyl butyrate, propyl acetate, acetic acid, iso-amyl alcohol were found to condense for a smaller supersaturation on the positive nucleus than on the negative. Water is the only known substance for which the negative ionic nucleus is more efficient than the positive. When air was bubbled through methyl, ethyl, and iso-amyl alcohols, ethyl, and propyl acetates, methyl butyrate, chloroform, and ethyl iodide, they became negatively electrified. F. J. B.

329. *New Formulæ Correlating Constants for Non-associated Liquids.* **E. Higgins.** (Amer. Chem. Soc., Journ. 30. pp. 1069–1078, July, 1908. Contribution from the Havemeyer Labs., Columbia Univ., No. 158.)—Kistiakowski has given the formula $AM/T = K$, where $A =$ rise in capillary tube of unit radius, $T =$ absolute boiling-point, $M =$ molecular weight, $K =$ constant (ranging from 1·04 to 1·17). In the case of drop-volumes a similar formula $vM/T = K$ (where $v =$ volume of falling-drop), gives for 5 non-associated liquids $K =$ 67·4, 67·3, 68·4, 67·6, 68·8, mean 67·9, with an average error of less than 1 per cent. in spite of the necessity for extrapolating the drop-volumes to the boiling-point. This formula can therefore be used with considerable accuracy for determining molecular weights from drop-volume and boiling-point. Given these three quantities, formulæ are deduced by which it is shown that the following constants of a non-associated liquid may be calculated with very fair approximation: (1) Surface tension; (2) critical temperature and pressure, and hence (3) vapour pressure at any temperature; (4) latent heat of evaporation; (5) a and b in van der Waals' equation.

T. M. L.

330. *Viscosity of Non-aqueous Solutions of Potassium Iodide.* **F. H. Getman.** (Amer. Chem. Soc., Journ. 30. pp. 1077–1084, July, 1908.)—The negative viscosity of potassium iodide in aqueous solution has been attributed [Abstract No. 1201 (1908)] to the kathion, the supposition being that the anions and undissociated molecules always increase the viscosity of the solution. Measurements of the viscosity of potassium iodide in methyl and ethyl alcohols, ethylene glycol, glycerol, furfural, acetone, and pyridine showed a negative velocity only in the case of glycerol. It is suggested that in related non-associated compounds the ratio (viscosity)/(mol. vol.) is constant throughout each series and that the great viscosity of glycerol in comparison with alcohol and other suggested compounds is due to an exceptional degree of polymerisation. This polymerisation is regarded as an essential factor in the phenomenon of negative viscosity, but the evidence is not at all conclusive, as solutions in glycol, a solvent with properties very similar to those of glycerol, shows large positive viscosities. T. M. L.

331. *Effect of Concentration and Ionisation on Rates of Diffusion of Salts in Aqueous Solution.* **R. Haskell.** (Phys. Rev. 27. pp. 145–182, Sept., 1908.)—A method is described for determining directly the specific diffusion rates of the undissociated and the dissociated parts of a salt. This consisted in

allowing the salt to diffuse upwards into a long cylindrical tube initially filled with pure water, keeping the concentration constant at the lower end. The concentration of the electrolyte was determined at different times by measuring the electrical conductance between pairs of Pt points placed at different distances along the tube. Three "runs" were made with thallium sulphate and barium nitrate, and the following results were obtained :—

	D (undiss.)	D (diss.)
Tl_2SO_4 (*a*)..	0·77	1·56
,, (*b*)..	0·80	1·50
$Ba(NO_3)_2$	0·69	1·40.

T. M. L.

332. *Saturated Aqueous Solutions of Sparingly Soluble Salts. Part II. Weight of Substance Dissolved at different Temperatures.* **F. Kohlrausch.** (Zeitschr. Phys. Chem. 64. 2. pp. 129–169, Sept. 4, 1908.)—The following table shows the solubility in mgm. per litre at 18° C. of the substances investigated :—

BaF_2	1605	$AgCl$	1·344	$BaSO_4$ ...	2·30	$BaCrO_4$..........	3·53	$CaC_2O_4.H_2O$...	5·54
SrF_2	117·3	$TlCl$	3063	Barytes...	2·61	Ag_2CrO_4	25·2	$ZnC_2O_4.2H_2O$	6·41
CaF_2	16·3	$TlBr$	423·3	$SrSO_4$ ...	114·8	$BaC_2O_4.2H_2O$	85·1	$CdC_2O_4.3H_2O$	33·7
Fluorspar	15·0	TlI..........	56·2	Celestine	114·3	$BaC_2O_4.3\frac{1}{2}H_2O$	105·0	AgC_2O_4..........	33·9
MgF_2......	87·4	$AgIO_3$ ...	38·5	Gypsum	2023	$BaC_2O_4\frac{1}{2}H_2O$...	75·5	PbC_2O_4	1·72
PbF_2	641	$Pb(IO_3)_2$	17·8	$PbSO_4$ ...	40·7	SrC_2O_4	46·1		
AgBr 21°......	0·108	Hg_2Cl_2	2	$PbCrO_4$......	0·1				
AgI 21°	0·0037	HgI_2(red) ...	0·3						

Values for other temperatures are given in the paper. T. M. L.

333. *Influence of Colloids and Colloid Suspensions on the Solubility of CO_2 in Water.* **A. Findlay.** (Chem. News, 98. p. 168, Oct. 2, 1908. Paper read before the British Assoc. at Dublin.)—The following results were obtained at 25° :—

Water		0·823	Dextrin	(5 per cent.)	0·768
Colloid $Fe(OH)_3$	(1·86 per cent.)	0·896	Sol. Starch	(5 ,,)	0·801
Gelatin	(5 ,,)	0·848	Glycogen	(1·18 ,,)	0·804
As_2S_3	(0·305 ,,)	0·822	Albumen	(0·5 ,,)	0·822
Silicic acid	(0·113 ,,)	0·823			

T. M. L.

334. *Vapour Pressure and Osmotic Pressure of a Volatile Solute.* **H. L. Callendar.** (Roy. Soc., Proc. Ser. A. 81. p. 336, Nov. 9, 1908.)—If the osmotic membrane be assumed to be impermeable to the solute, the formula for the change of vapour pressure of a volatile solute with hydrostatic pressure, and also the formula for the osmotic pressure which is deduced from it, must be the same as the formula for a non-volatile solute, and should not contain any terms depending on the vapour pressure of the solute, except in so far as it may affect the hydrostatic pressure of the solution. If, on the other hand, an osmotic membrane is regarded as a vapour-sieve, permeable to the vapour of the solution but not to the liquid phase, the equation takes a different form, depending on the concentration of the constituents in the vapour-phase. If c_1, c_2, &c., be the concentrations of the constituents in gm. per gm. of the vapour, and if U_1, U_2, &c., be the specific volumes of the constituents in the solution, the change of total vapour pressure

dp of the solution for a change of hydrostatic pressure dP is given by the relation $\Sigma c U dP = v dp$, where v is the specific volume of the whole vapour-phase. If only one constituent is volatile, this relation reduces to the form $U dP = v dp$ for that constituent. T. M. L.

335. *Determination of Vapour Pressures of Solutions with the Morley Gauge.* **O. F. Tower.** (Amer. Chem. Soc., Journ. 30. pp. 1219–1228, Aug., 1908.)—The method used is similar to that of Smits [Abstract No. 915 (1902)], but his micromanometer (usually filled with olive oil) is replaced by a Morley gauge containing mercury. The mercury in the gauge can be adjusted very accurately by noticing its contact with a pair of Pt points, and the displacement of the mercury by differences in the pressure of the vapour in contact with the two surfaces is compensated by tilting the whole of the gauge by means of a micrometer screw. Examples are given of the working of the method, but the author is inclined to recommend the "dynamic" method of measuring vapour pressure as being less troublesome and more flexible than any of the "static" methods. T. M. L.

336. *Osmotic Experiments.* **E. Cohen** and **J. W. Commelin.** (Zeitschr. Phys. Chem. 64. 1. pp. 1–52, Aug. 25, 1908.)—The paper contains a historical monograph in which reference is made to all the direct measurements on osmotic pressure up to 1908, followed by a destructive criticism of the rough experiments on which Kahlenberg [Abstract No. 1142 (1906)] based his statement that "the gas laws do not hold and cannot serve as a base for a satisfactory theory of solutions." A new apparatus is described in which several sources of error are eliminated in the measurement of the osmotic pressure of cane sugar dissolved in pyridine, with rubber as semi-permeable membrane. In spite of these substantial improvements, concordant measurements could not be recorded, one of the chief sources of difficulty being the absorption of moisture by the solution and by the solvent outside; further experiments are therefore needed before any reliable data can be forthcoming in reference to osmotic pressures in this solvent. T. M. L.

337. *Electric Osmose.* **J. C. W. Frazer** and **H. N. Holmes.** (Amer. Chem. Journ. 40. pp. 319–325, Oct., 1908.)—The following table shows the rates at which 0·001-N solutions of a series of nitrates flowed through a porous cell under the influence of an electric current :—

	Osmose.	Calculated Osmose.	Relative Specific Resistance.
KNO_3	100·0	100·0	100·0
$NaNO_3$	149·1	148·4	120·7
NH_4NO_3	102·9	101·6	98·7
$LiNO_3$	182·6	187·3	139·6
$CsNO_3$	96·6	95·2	—
$RbNO_3$	96·9	95·2	—
$\frac{1}{2}Ba(NO_3)_2$	58·4	61·0	108·9
$\frac{1}{2}Sr(NO_3)_2$	64·8	66·6	118·8
$\frac{1}{2}Ca(NO_3)_2$	61·8	65·1	114·8

It will be seen that the solutions studied follow rather closely the rule [Ibid. 36. p. 28, Abstract, No. 2184 (1906)] that the osmose of the nitrates of the alkalies and alkaline earths varies inversely as the velocity of the kathion divided by its valence (see calculated values in the third column). But the osmose does not seem to be proportional to the specific resistances of the solutions as shown in the fourth column. T. M. L.

338. *Decomposition of Ferro-metals (Ferro-Silicon) by Sulphur Chloride.* **P. Nicolardot.** (Comptes Rendus, 147. pp. 676–678, Oct. 19, 1908.)—In searching for a suitable reagent which would dissolve ferro-silicon and other ferro-metals for analytical purposes, the author observed that sulphur chloride (as used for the vulcanisation of rubber) readily attacks these alloys at moderately high temperatures. With ferro-silicon the attack begins at 70° C. and is violent at 100° C.; ferro-titanium is decomposed at the same temperature, ferro-chromium at 120° C. When the alloy is reduced to a coarse powder the transformation of the ferro-silicon into chlorides is accomplished in less than a quarter of an hour. The author describes an apparatus in which a large excess of sulphur chloride need not be employed. The observation is noteworthy in view of the use of ferro-silicon in electrochemical and other operations. [See Abstract No. 496 (1908).] H. B.

339. *Refractive Indices of Solutions.* **F. H. Getman** and **F. B. Wilson.** (Amer. Chem. Journ. 40. pp. 468–484, Nov., 1908.)—As a result of the investigation it was found that aqueous solutions could be divided into two classes, (*a*) those in which the specific refraction of the solute agreed with the value calculated from the atomic refractions of its elements, (*b*) those in which the two values did not agree. The former class consists of solutes which separate from solution in an anhydrous condition (although they may be hydrated when in solution), the latter of solutes which separate with water of crystallisation. Attempts to derive a formula for calculating the degree of hydration from the refractive indices led to no satisfactory results. T. M. L.

340. *Densities and Conductivities of Molten Salts.* **K. Arndt** and **A. Gessler.** (Zeitschr. Elektrochem. 14. pp. 662–665, Sept. 25, 1908.)—The electrical conductivities of KBr, KI, NaBr, NaI, AgCl, AgBr, and AgCl were measured according to a method previously described [see Abstract No. 1129 (1906)]. The temperatures ranged between 435° and 980° C., the temperature intervals varying with the different salts. Sodium metaphosphate and boric acid anhydride were also included among the salts, the ranges of temperature being respectively 685°–1,050° and 777°–1,084° C. At the same temperature the chlorides conduct better than the bromides, and the latter better than the iodides. The conductivity of sodium salts is about one and a half times as great as that of potassium salts. The best conductor is silver chloride. The temperature coefficients are much smaller than for aqueous solutions. The rule which was formerly found to hold for KCl and NaCl, viz., that the conductivity is proportional to the absolute temperature, is also approximately true for KBr, KI, NaBr, and NaI, and the appropriate interpolation formulæ are given. The rule also holds for Na metaphosphate, but it is not even approximately true for silver salts. The conductivities of mixtures of chlorides of Ca and Sr are strictly additive; those of mixtures of chlorides of K and Na only approximately so [see Abstracts Nos. 329 and 866 (1908)]. (Ibid. pp. 665–667, Sept. 25, 1908.)—The densities of various molten salts were measured by determining the weight of a given cylinder of Pt when immersed in the melt. Measurements were made on KCl, NaCl, $CaCl_2$, $SrCl_2$, $BaCl_2$, $NaPO_3$, and B_2O_3, and also on certain mixtures of the same. The

densities of mixtures of chlorides of Ca and Sr are approximately additive, whereas a big contraction takes place with mixtures of sodium metaphosphate and boric acid anhydride. From the densitities so obtained and the specific conductivities previously determined, the equivalent conductivities of the various salts are calculated. T. S. P.

341. *Ionic Concentration in Solutions of Lead Nitrite. Double Nitrite of Lead and Potassium.* **A. Chilesotti.** (Accad. Lincei, Atti, 17. pp. 178–188, Aug. 17, 1908.)—Measurement of the p.d. between Pb electrodes, one immersed in a solution of a Pb salt having a known concentration of $Pb^{\cdot\cdot}$, the other in a N/10 or N/12 solution of lead nitrite, and calculation of the concentration of the $Pb^{\cdot\cdot}$ ions by Nernst's formula, shows the concentration for a solution of $Pb(NO_2)_2$ to be practically the same as that of a solution of $PbCl_2$ of the same strength, the relative values for N/10 solutions of $Pb(NO_3)_2$, $PbCl_2$, $Pb(C_2H_3O_2)_2$, and $Pb(NO_2)_2$ being 8, 4, 3, and 4. Solutions of $Pb(NO_2)_2$ are very unstable, their conductivity increasing appreciably after standing a few days. W. H. St.

342. *Contribution to the Theory of Colloidal Solutions.* **L. Rolla.** (Accad. Lincei, Atti, 17. pp. 650–654, Dec. 6, 1908.)—The author has determined the mobility and electric charge of colloidal granules of gold and platinum prepared by Bredig's electric method, and of gold granules produced by Zsigmondy's process of reduction with formaldehyde. The Au granules in each case have a velocity, in a field of 1 volt per cm., of $26{\cdot}0 \times 10^{-5}$ cm. per sec., that of the Pt granules being $24{\cdot}0 \times 10^{-5}$ cm. per sec. No appreciable variation in the velocity of the granules could be detected on adding up to 0·01 per cent. gelatine. The charge found on the Au granules of Bredig is $12{\cdot}19 \times 10^{-10}$ e.s. units, those on Zsigmondy's being $9{\cdot}75 \times 10^{-10}$ for the red, $12{\cdot}19 \times 10^{-10}$ for the violet, and $16{\cdot}2 \times 10^{-10}$ for the blue, while that on Bredig's Pt granules is $11{\cdot}32 \times 10^{-10}$. These results give experimental support to Righi's hypothesis that colloidal granules resemble the large ions of Langevin and Bloch. W. H. St.

343. *Contributions to the Knowledge of Ozone.* III. *Potential of Ozone.* IV. *Heat Effect of the Decomposition of Ozone.* **S. Jahn.** (Zeitschr. Anorg. Chem. 60. 3. pp. 292–336, and pp. 337–358, Dec. 3, 1908. Physikal Inst. d. Techn. Hochschule, Charlottenburg.)—III. By making use of an acid solution of a mixture of cobaltous and cobaltic sulphate of known strength, and through which ozonised oxygen was passed, the author has determined by electrical methods the free energy of the decomposition of ozone. The stability domain of ozone is given by the formula $\log k = 7500/T + 0{\cdot}88 \log T - 5{\cdot}6$. The large value of the constant in this formula depends on the fact that deozonisation is a dissociation process. The mechanism of the evolution of oxygen is also discussed, and a possible explanation given of the anomalies which occur when the ozone potential is being measured. [See Abstract No. 198 (1906).] IV. The heat effect of the decomposition of ozone is found to be 34,100 cals. per gm. mol. The result is accurate to about ± 2 per cent. The ozone was decomposed in a specially designed calorimeter by passing over soda-lime. T. S. P.

344. *Measurement of a Homogeneous Chemical Change in a Gas: Thermal Decomposition of Ozone.* **H. E. Clarke** and **D. L. Chapman.** (Chem. Soc., Journ. 93. pp. 1638–1645, Sept., 1908.)—The results of previous investigations would seem to indicate that slow pyrogenic changes in gases have their seat of action principally, if not entirely, on the walls of the enclosing vessels and that any attempt to measure the velocity of change within a gas itself would be unsuccessful, owing to the impossibility of estimating the precise effect of surface. The authors find, however, that the influence of surface on the rate of thermal decomposition of ozone at 100° in a glass vessel becomes negligible when the vessel is increased in size to quite moderate proportions. The results obtained are the first recorded examples of measurements of the velocity of a strictly homogeneous change in the gaseous state. If a gas of given composition undergoes slow chemical change in a vessel of volume V and area A, the rate of change may be expressed approximately by $KV + kA$, where K is a constant depending on the composition of the gas and k is another constant depending on both the composition of the gas and the nature of the surface. The rate of change per unit volume will be $K + kA/V$, and, if the action is accompanied by alteration of pressure, we have—

$$\partial p/\partial \tau \propto K + kA/V,$$

p being the pressure at time τ. In the experiments of the authors, two vessels, of which the ratios A/V were very different, were filled with the same sample of ozonised oxygen and heated side by side in a bath of boiling water. The rate of increase of pressure was in all cases found to be about the same in each vessel, so that the term kA/V could be neglected and the rate of decomposition taken as being directly proportional to K, a constant the value of which at any given temperature and pressure is determined solely by the composition of the gas. T. H. P.

345. *Thermal Decomposition of Hydrocarbons.* I. **W. A. Bone** and **H. F. Coward.** (Chem. Soc., Journ. 93. pp. 1197–1225, July, 1908.)—By means of an arrangement of two coaxial porcelain tubes methane, ethane, ethylene, and acetylene were heated to definite temperatures between 500° and 1,200° and the products of decomposition systematically examined. Methane, which is by far the most stable of the four hydrocarbons and a principal product of the decomposition of the other three, decomposes for the main part directly into carbon and hydrogen. The decomposition of methane is chiefly a surface effect, whereas that of the other three takes place throughout the main body of the gas. Acetylene is a principal product of the decomposition of ethylene, but not of either methane or ethane, and the equation put forward by Lewes for the decomposition of ethylene is invalid. According to the authors, the large quantities of methane formed during the decompositions of the other three hydrocarbons can only be explained by the supposition that residues such as $\vdots\mathrm{CH}$ and $:\mathrm{CH_2}$ are directly hydrogenised in an atmosphere rich in hydrogen. D. H. J.

346. *Conductivity and Ionisation of Electrolytes in Aqueous Solutions as conditioned by Temperature, Dilution, and Hydrolysis.* **H. C. Jones** and **C. A. Jacobson.** (Amer. Chem. Journ. 40. pp. 355–410, Oct., 1908.)—The following points are said to have been verified or established by the present work: (1) The molecular conductivity of electrolytes in aqueous solution increases as a parabolic function of the temperature from 0° to 35°. (2) Conductivity increases with increase in dilution. (3) With increase in dilution dissociation increases up to a max. value where it is complete. (4) Hydrolysis is a formidable source of error in obtaining the true value for μ_∞ and, consequently, in obtaining the true dissociation. (5) Disregarding the effect of hydrolysis, dissociation decreases with rise in temperature. (6) The conductivity of water is a linear function of the temperature. (7) Salts that are strongly hydrated in solution show a greater increase in conductivity with rise in temperature than the salts that are slightly hydrated. (8) The temperature coefficients, expressed in conductivity units, increase with rise in temperature. Those of the organic acids are exceptions. (9) The temperature coefficients expressed in percentages decrease with rise in temperature. (10) The temperature coefficients of compounds with similar properties vary in a similar manner with change in temperature. It should be noted that these statements are only true for a limited number of electrolytes over a narrow range of temperature, *e.g.*, the parabolic formula (§ 1) is only a rough approximation, covering a limited part of an inflected curve; the conductivity of water is expressed more accurately by an exponential curve than by a straight line (§ 6); the increase in the temperature coefficient (§ 8) is limited to salts at low temperatures—salts at high temperatures and mineral acids at ordinary temperatures give decreasing coefficients; alkalies give an almost constant temperature coefficient, decreasing at higher temperatures.

T. M. L.

347. *Latent Heat of Fusion, Specific Cohesion and Molecular Magnitude at the Melting-point.* **P. Walden.** (Zeitschr. Elektrochem. 14. pp. 713–724, Oct. 23, 1908. Phys. Chem. Laborat. des Polytechnikums, Riga, Sept., 1908.)—The author discusses the following relationships involving the latent heat of fusion and vaporisation, and the melting-point and boiling-point:—

$M^{\frac{1}{3}}/D - \frac{1}{3}\alpha T =$ const. (Pictet, 1879).
$ML/T\Sigma v = 1{\cdot}38$ (Crompton, 1895).
$DL/T = 0{\cdot}099$ (Crompton, 1897) (for non-associated liquids).
$DM/T = 2{\cdot}96$ (Crompton, 1903) (for monatomic liquids, *e.g.*, for 14 metals).
$ML/TV^{\frac{1}{3}} =$ const. (1·13 for monatomic metals, 2 for inorganic salts, 2·2 to 3 for organic compounds (Robertson, 1902).
$L + S/T =$ const. $= 30$ (Forcrand, 1903).
$T/\theta = 2$ (Clarke).
$S/a^2 =$ const. (Walden, 1908), $MS/T' =$ const. (Trouton), whence $Ma^2/T' =$ const.
$M =$ mol. wt.
$D =$ density.
$\alpha =$ coefft. of linear expansion.
$T =$ melting-point.
$T' =$ boiling-point.
$\theta =$ critical temperature.
$\Sigma v =$ sum of valencies.
$L =$ latent heat of fusion.
$S =$ latent heat of vaporisation.
$V =$ atomic or molecular volume.
$a =$ specific cohesion.

To these relationships are now added by analogy with the last three: $L/a^2 =$ const. $= 3{\cdot}6$, $Ma^2/T =$ const. $= 3{\cdot}65$, $ML/T =$ const. $= 13{\cdot}5$, where $a =$ specific cohesion at the melting-point. These relationships hold good for non-associated liquids, and can be used to determine the factor of association when this is not unity. The third relationship appears to be particularly reliable, and gives the latent heat of fusion about as accurately as it can be deduced from cryoscopic observations. The following values are deduced by means of the second and third of the above formulæ for the association-factors of fused salts :—

KNO_3	1·7	1·8	KCNS	—	1·3
$NaNO_3$	1·4	2·1	Na_2SO_4	—	1·7
$AgNO_3$	—	1·42	K_2CO_3	—	1·9
$NaClO_3$	1·4	1·86	$PbCl_2$	1·8	2·8
AgCl	2·2	2·25	$PbBr_2$	2·3	2·2
$AgClO_3$	—	1·90	$CdCl_2$	—	5·0
NaCl	—	9	HgI_2	1·2	—
NaBr	—	8	$SbBr_3$	1·4	1·8
NaI	—	6·2	$AsBr_3$	1·3	—
KCl	—	7	$SnBr_4$	1·8	—
KBr	—	7	$POCl_3$	1·15	1·55
KI	—	5	$AlBr_3$	1·8	—

T. M. L.

348. *Limiting Conductivity and Degree of Ionisation of Alcoholic Solutions.* **B. B. Turner.** (Amer. Chem. Journ. 40. pp. 558–574, Dec., 1908.)—(1) The precautions necessary to obtain reliable results for the conductivity of alcoholic solutions up to dilutions of 20,000 to 50,000 litres have been ascertained. A source of error in the contamination from glass vessels in which water has been dried is pointed out. (2) The conductivity of potassium iodide has been measured up to 450,000 litres, and the molecular conductivity has been shown to reach a max. of 48·5 ± 0·5 reciprocal ohms at 25° at about 20,000 litres. A similar maximum appears to exist at all temperatures. (3) From measurements at 0°, 15°, 20°, 25°, 50°, 65°, and two measurements in sealed cells at 78°, the ionisation coefficients have been calculated for all concentrations and temperatures up to the boiling-point. (4) The temperature coefficients increase with rising temperature, slightly for the stronger solutions and much more noticeably for very dilute solutions. At any given temperature the temperature coefficient increases with increasing dilution. (5) The ionisation decreases considerably with rising temperature. A 0·1-N solution is dissociated 49 per cent. at 0°, 46 per cent. at 25°, and about 35 per cent. at the boiling-point. (6) The temperature coefficient for pure alcohol is much less than for alcohol with a conductivity of $0·3 \times 10^{-4}$ reciprocal ohm ; it may even be negative. T. M. L.

349. *Time-curve of Galvanic Polarisation.* **H. H. Bunzel.** (Ann. d. Physik, 27. 2. pp. 436–448, Oct. 15, 1908. From the physikal.-chem. Inst. d. Univ., Berlin.)—Use is made of the capillary electrometer for the study of the time-curve of galvanic polarisation. The results show that, with weak enough currents and condenser discharges which are not too short, the capillary electrometer conforms to the ordinary laws of galvanic polarisation. By means of the electrometer several relations which can be deduced from the general theory, especially in respect to condenser discharges, were tested and found to hold. [See Abstracts Nos. 707, 708 (1899) ; 3188 (1904) ; 1507 (1905).] T. S. P.

350. *Aluminium "Valve" Cell as Condenser.* **J. de Modzelewski.** (Lumière Électr. 3. pp. 187–188, Aug. 8, 1908. Thesis, Fribourg Univ., 1908.)—The author's experiments were carried out with a cell having Al anodes and Ni as kathode in a 6 per cent. ammonium bicarbonate solution. It is found that high degrees of formation can only be obtained by slow and gradual increase of the applied voltage and by a supplementary formation at a lower voltage than the first formation voltage. The ohmic resistance of the film increases, for a given voltage, with the formation voltage, and diminishes as the applied voltage increases; thus for plates formed at 274 volts the resistance per cm.^{2} varies from 20·9 × 10^6 to 1·06 × 10^6 for a voltage varying from 89·2 to 147 volts. The author uses plates formed in this way as condensers in alternating-current circuits, and at the same time re-forms the oxide film by means of a rectified current applied to the Al plates through an auxiliary kathode. The capacity of the condensers obtained in this manner was about 15 mfd. The following table shows the behaviour of such a condenser with plates formed at 274 volts:—

Applied Voltage.	Current in Amps.	Apparent Power, Volt-amps.	Losses in Watts.	Losses in Per Cent. of Energy Consumed.
98·5	0·417	41·07	2·52	6·1
88·9	0·384	34·14	2·05	6·0
78·9	0·332	26·19	1·55	5·9
72·3	0·305	22·05	1·28	5·8
60·4	0·250	15·10	0·85	5·6
50·6	0·219	11·08	0·60	5·4
42·4	0·180	7·63	0·40	5·2
30·2	0·140	4·23	0·21	4·96

It is considered impossible to utilise previously formed plates as a condenser, owing to the rapid increase in the losses and the destruction of the film; but by combining the use as condenser with a simultaneously proceeding formation as indicated, good results may be obtained. [For actual arrangement see Abstract No. 146B (1909).] L. H. W.

351. *Separation of the Alkali Metals in the Electrolytic Way.* **J. S. Goldbaum** and **E. F. Smith.** (Amer. Chem. Soc., Journ. 30. pp. 1705–1711, Nov., 1908. Contribution from the John Harrison Lab. of Chemistry.)—The separation of the alkali metals by the method of graded potential has been effected in the Hildebrand cell. The e.m.f. necessary for the deposition of, for example, sodium alone from a solution containing the chlorides of sodium and potassium, was determined for the particular cell used by finding the "break-point" in the curve showing the relation between e.m.f. and current. The results so obtained could then be used for the quantitative separation of sodium and potassium. In this way the separation of the following metals in chloride solutions were quantitatively carried out: Na—K, Na—NH_4, Na—Cs, Na—Rb, Na—Li, K—Rb, K—Cs, K—Li, Cs—Rb, Li—Rb, Li—Cs. Preparatory to the separations it was shown that NH_4, Cs, Rb, and Li could be estimated satisfactorily in the Hildebrand cell. For the estimation of NH_4 it was necessary to bring the electrodes nearer together than usual (1 cm. apart) and to increase the speed of rotation of the anode to 750 r.p.m. An initial e.m.f. of 3 volts, slowly increasing to 8 volts, and, as the end of the electrolysis approached, gradually returning to 3 volts, was employed.

T. S. P.

352. *Electrolytic Production of Borates.* **M. G. Levi** and **S. Castellani.** (Accad. Lincei, Atti, 17. pp. 613–617, Nov. 22, 1908.)—In a beaker containing

a saturated solution of boric acid are immersed two Pt electrodes, each having a surface of 18 cm.^{2}, and between the electrodes is inserted a diaphragm containing a 10 per cent. solution of the chloride or other salt of the metal, and a carbon anode. On passing a current of 0·5 to 1 amp., at the ordinary temperature, through such a system, a white crystalline deposit is formed on the kathode during the first hour, consisting of the metaborates, $CaO . B_2O_3 . 4H_2O$, $SrO . B_2O_3 . 4H_2O$, and $BaO . B_2O_3 . 4H_2O$ respectively. Subsequently a white flocculent mass is precipitated around the kathode, and a further white precipitate is also produced when alcohol is added to the filtered kathode liquor. The precipitates formed spontaneously, or on addition of alcohol, are acid borates, that obtained with calcium corresponding to the pyroborate $CaO . 2B_2O_3$. With Mg a white deposit is produced at the kathode containing a large excess of MgO over B_2O_3, and probably consisting of $MgO . B_2O_3$, mixed with MgO; on addition of alcohol to the kathode liquor a substance approximating in composition to $3MgO . 4B_2O_3$ is obtained. To secure the precipitation of true borates when alcohol is added the quantity of electricity should be so regulated that the existence of OH′ ions at the kathode is prevented by a permanent small excess of H′ ions. Experiments with Cu, Cd, Hg, Pb, Fe, and Ni all gave a deposition of metal at the kathode, with precipitation of oxide and of a small quantity of borate. The hydrolysing action of water on the borates is a factor not to be ignored.

W. H. Si.

353. *Experiments on Electrolytic Galvanising.* **C. Richter.** (Elektrochem. Zeitschr. 15. pp. 194–198, Dec., 1908.)—The author has been successful in carrying out electrolytic galvanising in such a way that the zinc deposit obtained is as good as that obtained by the ordinary method. The bath used contained 140·23 gm. $ZnSO_4 7H_2O$, 42·59 gm. $(NH_4)_2SO_4$ and 1·274 gm. H_2SO_4 per litre, and it was necessary to add a solution consisting of 1 gm. H_2SO_4, 20·882 gm. H_2O and 0·889 gm. $(NH_4)_2SO_4$ as the electrolysis proceeded. The current density varied from 1·5 to 2 amps./dm.^{2} at 1·6 to 2·4 volts at ordinary temperatures. The author supposes that the successful results are due to the zinc being secondarily deposited, but no evidence is given in support of this.

T. S. P.

354. *The Nature of Supertension.* **E. Müller.** (Zeitschr. Elektrochem. 14. pp. 429–433, Aug. 7, 1908.)—A further reply to Kaufler [compare Abstracts Nos. 1976 (1907) and 1351 (1908)]. Kaufler observed that lead showed a higher kathode potential than smooth Pt in sulphuric acid, and assumed that this would hold for the reduction of benzophenone and of acetophenone, overlooking the influence of the depolariser. Müller finds that the two kathodes give practically the same potential in the first reduction, and that Pt has the higher potential in the second. The statements about the oxidation of *p*-nitrotoluene are also contradicted. As regards Kaufler's electrolysis of sulphuric acid with a lead kathode when the temperature was lowered by the addition of the depolariser, copper sulphate, Kaufler had disregarded the fact that the electrode was changed by the deposition upon it of copper. Müller fully maintains his criticisms. **F. Kaufler.** (Zeitschr. Elektrochem. 14. pp. 737–740, Nov. 6, and pp. 749–752, Nov. 13, 1908.)—In reply to E. Müller [Abstracts Nos. 345 and 1351 (1908)] the author explains his arrangements and arguments, and states that lead is indeed more kathodic than smooth Pt in the reduction of acetophenone and benzophenone. This was the view of Tafel and Elbs, is supported by Kaufler's new experiments,

and results, moreover, from Müller's own experiments which were to prove the contrary. In the fourth paper Kaufler refers to the connection between electro-capillary phenomena and the transition resistance at mercury electrodes according to Billitzer, and describes experimental determinations, made by himself and N. Konstantinow, of that resistance. The mercury covered the bottom of a glass vessel of 28 cm.^{2} area, and was kept at rest or in motion. The anodes consisted of a rod and an inclined disc, made either of Pt or Pb; the electrolyte was sulphuric acid; in some experiments the mercury was frozen at 45° C. The transition resistance at the kathode was, for currents of 9·025 amps. 14 ohms/cm.^{2} with the Pt anode, and 10 ohms with the Pb anode; movement of the mercury did not make any difference; with the frozen mercury the resistance was very high. H. B.

355. *Formation of Ozone with Rotating Anodes.* **F. Fischer** and **K. Bendixsohn.** (Zeitschr. Anorg. Chem. 61. 1. pp. 13–39, Jan. 4, 1909.)—The authors have investigated the effect of rotating the anode on the yield of ozone in the electrolysis of solutions of sulphuric acid. Special apparatus was designed for the purpose, for details of which the original paper should be consulted. The electrodes used were either of wire or foil. The latter were of two kinds. In the one, two pieces of Pt-foil were sealed through the opposite walls of a cylindrical bulb, the lengths of the foil being parallel to the axis of the bulb. The parts of the foil which projected on the outside of the bulb were ground smooth with the surface of the glass, so that practically a line electrode was obtained of width equal to the thickness of the foil. Connection with the source of current was made by means of mercury in the bulb. In the second kind of electrode a piece of Pt-foil was sealed between two circular glass plates and the edges of the foil ground smooth with the glass surface. The results obtained were as follows: Higher yields of ozone were obtained with rotating than with stationary wire electrodes of 0·4 mm. diameter. The absolute concentration of ozone (0·69–2·39 per cent.) was, however, small, because the surface of the wire exposed to the electrolyte was comparatively large. Very thin platinum wires could not be used, since they either broke during the rotation, or else were eaten away when the electrode was kept stationary. High concentrations of ozone could be obtained with the foil electrodes, but the yield depended to a great extent on the relative position of the foil to the surface of the glass. The highest concentrations (21·4 per cent. by weight) were obtained with rotating foil electrodes of the second kind described above. The high ozone concentration does not depend on the rotation, but on the small surface exposed to the electrolyte, since when the same electrodes were kept stationary a concentration of 23·4 per cent. ozone could be attained at 10° C. Rotation helps to preserve the foil electrodes, since it prevents the accumulation of hot acid at the surface of the platinum, which is not eaten away so quickly. [See also Abstract No. 547 (1907).] T. S. P.

REFERENCE.

356. *Another Method of Measuring Large Molecular Masses.* **W. Sutherland.** (Phil. Mag. 16. pp. 497–512, Oct., 1908.)—The method depends on conductivity measurements, and gives 11,650 for the molecular weight of the globulin ion, and 2,270 for that of the casein ion. T. M. L.